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CONTENTS.

THE DEVELOPMENT OF SISAL HEMP CULTIVATION IN INDIA.

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In India the commercial cultivation of Sisal Hemp (*Agave sisalana*) and of other allied fibre plants was begun five or six years ago chiefly in Eastern Bengal and Assam. Previously these plants were used mostly for ornamental purposes in gardens and occasionally as hedges for compounds and along railways and canals.

In Eastern Bengal and Assam an industry in Aloe Fibre is now established which will probably flourish. The Agave plantations in this Province extend over considerable areas. These lands were previously unoccupied and were considered unsuitable for the ordinary crops of the country. The cultivation of Agaves and of Mauritius hemp (*Furcraea gigantea*) is likely to become a permanent industry in Eastern Bengal and Assam. The climate seems to suit the latter plant especially. The cultivation of Agaves has also extended into the Bengal divisions of Chota Nagpur, Sambalpur and Behar and, to a less extent, into the Provinces of Madras and Bombay.

In Eastern Bengal and Assam there are two principal suitable areas, one in Sylhet and the other in Chittagong, with smaller developments in Cachar and elsewhere. In Sylhet there are at least six plantations which now each extend to several hundred acres. The largest plantation is at Dauracherra. Its extent is over 1,000 acres and it is owned by a limited liability Company which is not directly connected with any tea estate. Most of

Note.—The present article may be considered as a supplement to a pamphlet by the Author and Mr. J. Hunter, published by the Indian Tea Association in 1904.

the other plantations in Assam are owned by Tea Companies. This secures economic supervision. In Sylhet the total area under Agaves in 1907 is approximately about 4,000 acres and in Chittagong about 1,000 acres, but in the latter division extensive developments are likely in the near future. It is probable that before January 1908 at least 6,000 acres of Sisal Hemp and allied fibres will be growing in the Tea districts of North-East India. The extent of cultivation elsewhere in India cannot be at present estimated, but it is considerable.

I need not repeat the information given in another place (see foot-note, page 323), regarding the characteristics of the plants or the method of their growth and flowering. There are two methods of reproduction and often three. In a period varying from four to fourteen years under Indian conditions, each plant sends up a straight flowering stalk termed a "pole." The plant dies when it poles. The pole produces, where a flower would normally arise, a young plant termed a bulbil, which, when disentangled from the pole by wind or otherwise, falls to the ground and may there take root or can be used for planting out new areas. These bulbils are very tenacious of life and can be transported long distances if carefully packed. If packed moist, they are liable to become rotten.

From many of the species, seeds are produced from flowers in the usual way, but this is not the case with Sisal Hemp.

Some Agave plants have another method of reproduction. In the first or second year after planting and subsequently, root stocks are thrown out. These are commonly called suckers. They can be separated from the parent plant and can be planted out. Our experience shows that among all the species and varieties of Agave and related plants, the true Sisal Hemp (*Agave sisalana*) is the best for India. It grows, when placed on suitable soil, vigorously, and is more profitable than other species under ordinary climatic conditions. The latest experience at Daura cherra (Assam), is that the leaf will yield four per cent. of fibre of which three per cent. is first class, and one per cent. is short and inferior.

In Eastern Bengal and Assam, Mauritius Hemp (*Furcræa gigantea*), owing to particular climatic conditions, will probably thrive better than Sisal Hemp. It grows more vigorously than Sisal Hemp and has so far not been subject to attack by insects or disease. On the other hand, the percentage of fibre obtainable from the leaves is much smaller than from Sisal Hemp. As the leaves are much larger and heavier than those of Sisal Hemp. this may not mean much less fibre per acre, but it would mean that the cost of carriage of leaf for the same amount of product would be considerably greater. The large machines which satisfactorily extract fibre from Sisal Agave would probably be found unsuitable for Mauritius Hemp. There are, however, a number of smaller machines which satisfactorily clean Mauritius Hemp, but these are not economical when large areas have to be dealt with.

In the light of experience I am convinced that true Sisal Hemp (*Agave sisalana*) is the best of all the Agaves for large plantations in India, but if a good fibre-extracting machine for Sisal Hemp cannot be economically provided, then Mauritius Hemp (*Furcræa gigantea*), may possibly be found more profitable in certain parts of North-East India if the fibre in good quality can be extracted in the ordinary country way.

A recent publication* by M. Hautefeuille of the Agricultural Department of French Indo-China states that in India Sisal Hemp was most likely to succeed in the rocky elevations of Southern Peninsular India, and in certain waste portions of the Punjab and Rajputana. Our experience in North-East India is all against the use of rocky elevations, or poor and shallow soils and the waste portions of the Punjab without irrigation will grow practically nothing. It has been proved that in North-East India Sisal Hemp will not grow satisfactorily on poor stony soils, or on the old abandoned tea lands. The plants can only grow rapidly and vigorously if the planting is done carefully and if the land is moderately good. Our conditions of soil and climate may

* This was reviewed in the *Agricultural Journal of India* for July, 907, by Mr. R. W. B. C. Wood,

not be so generally favourable as those of Yucatan where the plant grows excellently, but it is certain that there is no use devoting anything but fairly good land to the culture of Sisal Hemp in India. On poor soil with deficient rainfall the leaves are short, leading not only to a smaller crop but also to a shorter and much less valuable fibre. I believe that the lack of success in many of the attempts at experimental culture has been due to the selection of soil too poor for the purpose. Other factors may however have influenced results. A perfectly drained soil, as also one which is moderately light, is necessary.

The principal difficulty in the rapid extension of Sisal Hemp culture in suitable districts is the absence of plants. True Sisal Hemp plants are in great demand, whether they be bulbils or suckers. Opinion is generally unanimous that suckers should be planted rather than bulbils. Mr. R. T. Fraser, who has a large young plantation in South Sylhet, is of opinion that the ideal method is to allow the sucker to remain attached to the parent plant until eight to twelve inches high, and then plant it out.

Experimental planting has failed in large measure in India owing to the selection of unsuitable soil, and failures have also occurred because sufficient attention and care was not given to the planting. It is generally supposed that Sisal Hemp is a cheap crop. Some of the first plantations were formed with this idea, and the result has been that the areas so dealt with are notably inferior in growth and more uneven than those which have since been made with greater care. A Sisal Hemp plantation will cost as much as a tea plantation in the first instance. Every plant should be planted carefully with roots well spread out in a pit of soft soil of four to six inches deep and twelve inches wide. The soil should be pressed down hard, immediately watered, and a slight mulch of light branches or forest leaves be placed round each plant. The plant should not be sunk below the level of the crown. The soil should be pressed down so as to leave the plant firm in its position.

Experience has shown that planting is most successful when showery weather immediately follows the planting. March and

April are usually the ideal planting months. In Eastern Bengal and Assam, some areas planted during the height of the rains have been successful, as have others planted with big plants in November and December. But in North-East India planting is most successful in the two or three months of showery weather which precede the breaking of the monsoon.

The distance apart of the plants has been a matter of much discussion. The general opinion is now in favour of somewhat closer planting than was done on the pioneer estates. Eight feet by four feet is the distance now commonly suggested. Mr. R. T. Fraser put his plants out in double rows four feet apart with four feet between plants in a row and then a space of eight feet to the next double line of rows. At Dauracherra, nine feet by four and a half is the common distance. So long as the plants grow equally vigorously, and there is enough space to harvest the leaves, it is evident that the closer the planting the bigger will be the yield per acre, but in Mr. Fraser's planting I fancy that the limit has about been reached.

Plants should be put out big. I have already mentioned that it has been found desirable to transplant young plants when they are eight to twelve inches high. If they thrive they will take root at once and give little or no further trouble.

Especially must the soil be kept loose and free from weeds by hand hoeing round each young plant. This cultivation should be subsequently continued to secure as rapid growth as possible. It is not advisable to grow catch crops on land which is planted with Sisal Hemp. On one plantation in Sylhet an attempt was made to get a crop of cotton when the plants were small. The result was practically fatal to the Sisal Hemp. "The small plants are making slow progress and the plantations will take years to recover if even it does recover at all."*

It is probable that the amount of cultivation usually recommended for an established plantation is less than is actually required for the most profitable results. Among planters in

* From a very well informed article in *Capital*, Calcutta, 8th August 1907.

Eastern Bengal and Assam it is generally considered that by liberal cultivation only can vigorous growth and profitable results be obtained on good or fairly good land. It is essential to keep the ground fairly loose and also free from strong-growing grasses and rank weeds. My insistence in previous publications of the necessity for cultivation, amounting to at least three hoeings or weedings per annum, has been confirmed by more experience.

In the third year from putting out the plants (if they are planted of the size I have suggested), they will have attained a height of from four to five feet, and are then big enough to permit the cutting of a few leaves The leaves open from a central core, and gradually are pushed out from the centre by the new growth, until they finally reach a position nearly at right angles to the stem. After they become distinctly sloped from the perpendicular they grow no more, but become more mature. Those leaves which have reached a point forming half a right angle with the trunk can with advantage be removed.

In North-East India the season for cutting is limited by the period in which the prepared fibre can be dried. Specially heated drying sheds cannot be economically provided. Drying in the open air, limits the period of cutting between October and June. The method of cutting is very simple, and a good man will cut three thousand leaves a day. An ordinary tree pruning knife with a blade eight inches long, is suitable for this work. The Yucatan pattern of knife could probably be used with advantage in India.

The age when Agave plants "pole" and die in India, affects the success of the industry very largely. In a recent publication* it was stated that "any of the Indian Agaves may flower by its seventh year or even earlier." If this is true of Sisal Hemp there would be no success in planting. It would not pay. Experience at Dauracherra seems to indicate that normally the age of poling is about eleven to thirteen years. Occasionally a few plants pole quite early. I have even seen bulbils poling

* Agricultural Ledger, No. 7 of 1906, by Drummond and Prain.

while still attached to the parent. But such poling is exceptional. Ordinarily leaves can be cut annually from plants which are of three to eleven years old. Three cuttings can be obtained each season before April.

I have said that on a large scale, and with our usual methods of extraction, about $3\frac{1}{2}$ to 4 per cent. of fibre is regularly obtained on the weight of leaves at Dauracherra, and only about half this amount with Mauritius Hemp. On existing plantations the amount of fibre obtained is about half a ton per acre per annum. In the plantations more recently put out and more closely planted this amount may be exceeded.

The crop is bulky and weighty, and as it only yields 4 per cent. of marketable produce, the question of transport of crop and refuse to and from the factory is important. In a large plantation, a system of light tramways would probably solve the problem.

A plantation of six hundred acres of Sisal Hemp can be worked economically with the present machinery. One smaller than this will hardly keep a full-sized automatic machine in full work, and if smaller machines be used, the cost of extraction per pound of fibre is immediately increased.

The machinery for fibre extraction may be divided into three classes, all being run by power. Hand machines like the 'Raspador' formerly used in Mexico, may be suitable for those who contemplate Sisal Hemp culture as a small home industry, but they are not in any sense suitable for use on a plantation scale.

During the early days of a plantation when the leaves are short and the quantity is small, the machine which has in the last three years proved itself the best is the 'Harrison' sold by the Eastern Landing, Clearing, and Forwarding Co., of Calcutta, for about Rs. 300. It has a much smaller rasping or scutching wheel than the 'Raspador' and runs at a much higher speed, being made entirely in iron. It will turn out 2 cwt. of fibre a day and requires two men to work it, with three-quarter horse power to drive the machine. This has been so successful that some of our planters at one time thought it might be possible to work a plantation with a battery of 'Harrison' machines

Though this idea has had to be given up, yet it indicates the opinion held of the work which the machine will turn out.

The second group of machines, which I may call semi-automatic, and in which several leaves are dealt with at once, have not been a great success in India, and I would on the whole prefer a battery of 'Harrison' machines. Their advantage is that they all feed the leaf into the machine from end to end, and so there is much less chance of the fibre being damaged than with the larger automatic type, where the leaves are fed sideways. Their disadvantage is that the fibre has to be drawn back out of the machine by hand after being scutched, an operation involving hand labour and slow working. In a machine put on the market by Messrs. Burn & Co. early in 1906, an attempt was made to get over this difficulty, but the cleaning was not efficient, and while the idea seemed to be good, it was by no means perfected. The automatic machines which are alone suitable for large estates are all of the same general type, and only differ really in the manner of holding the leaf. Two types have only been used in India, the 'Todd' and the 'Torruella' machines.* The former is the favourite in the Bahamas, the latter one of the best in Yucatan. Both have now been carefully tested in our districts, and it may be stated that :—

(1) The scutching arrangement is best in the 'Todd' machine, the fibre comes out cleaner, and there is less waste.

(2) The gripping arrangement is very much better on the 'Torruella' machine. In the 'Todd' the chain grip has given a great deal of trouble; it is apt to loosen, and it requires constant attention. The 'Torruella' grip is perfect.

(3) Both of them are apt to clean small and short leaves badly or even miss them altogether.

(4) Neither is suitable for Mauritius Hemp as the leaves are apt to break across the middle.

It is apparently, in our districts, impossible to get the work out of the machine which is claimed by the inventor, and the

* For a description and illustrations of these machines, I must refer to my former publication.

absolute maximum the 'Torruella' can do is 100,000 leaves per day of ten hours with four men and 16 horse power. The 'Todd' does less than this, say 50,000 to 60,000 leaves per day.

I have now to discuss the commercial prospects of the industry, so far as they have changed during the past three years. The accumulating evidence seems to make it clear that my former estimate of the cost of putting out a Sisal Hemp estate is not far off the mark. The cost of the fibre delivered in London from a mature Sisal Hemp plantation of an economical size, will be about £14 to £15 per ton. It may be, of course, that as experience increases, this amount may be capable of reduction, but this has not been possible hitherto. Thus at present the cost of running an estate, including freight of the fibre to London, will be about £7 to £8 per acre per annum. This amount is about the same as the cost in the Bahamas and a little under the cost in Yucatan. The production in these countries is increasing though only gradually, and they are, of course, the principal sources of supply. The export from each of these places, according to the latest returns I have been able to obtain, is as follows :—

Mexico (including Yucatan).

Year.	Bales.	Tons.
1896 ...	397,163	66,194
1897 ...	419,983	69,997
1898 ...	418,972	69,829
1899 ...	445,978	74,330
1900 ...	499,634	83,272
1901 ...	517,519	86,253
1902 ...	...	105,913
1903 ...	...	121,944

Bahamas.

Year.	Pounds.	Equivalent in tons.
1898 ...	1,251,730	559
1899 ...	1,358,682	606·5
1900 ...	1,276,037	570
1902 ...	2,345,311	1,047
1904 ...	2,218,825	990·5
1905 ...	3,040,045	1,357

A few other sources of Sisal Hemp fibre are opening, but the amount produced is as yet very small. The plant is now being cultivated in Guiana, and experimentally in British Central Africa. No less than 611,000 pounds were exported from Hayti in the four months ending January 31st, 1905. An attempt is being made to introduce the culture into French Cochin China and extend it in the Philippines. In Algeria it has been much pushed, but my latest information is that little progress is being made. On the other hand, Indian Sisal Hemp has won a recognised place on the market and is quoted as such. The best of it, too, obtains prices almost if not quite equal to those given for the material from Yucatan.

A good deal of the future of the industry depends on the maintenance of the price of this and similar fibres. And from all that can be seen of the fibre market at present, there seems little fear of a serious drop for some years to come. At the same time one must not forget that the prices have been subject to violent fluctuations in the past, and these may easily occur again in the future. For seven or eight years, however, they have remained remarkably stable as the following figures show. The prices are those on the London market :-

Year.	Sisal Hemp.		Manila Hemp.	
	June.	December	June.	December.
	£	£	£	£
1900	39	30	39	31
1901	[illegible]	42	33	46½
1902	42	40	41½	37
1903	39	36	35	41
1904	35	36	36	42
1905 ...	37	39	39	41½
1906	33	35	43	42½
1907 ...	33½	...	38	

On the whole, therefore, I think that the additional experience of the past three years has confirmed the conclusion to which I was led in 1904, that in many parts of North-East India, Sisal Hemp fibre can be produced in competition with nearly all—if not with all—the countries and districts in which

it has been tried, that the quality will remain as good as that obtained from America, and that it will be a number of years at least before there is likely to be any such slackening in the annual increase in the demand as to lead to serious overproduction and so bring the price below a remunerative figure. Under these conditions with the additional knowledge we now have of the methods of culture and preparation for market, I think there is every prospect of the building up of a flourishing planting industry in the North-East of India.

AUTUMN RICE OR AMAN PADDY EXPERIMENTS AT BURDWAN IN BENGAL.

By F. SMITH, B.SC., F.H.A.S.,

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AUTUMN Rice, Transplanted Rice or Aman Paddy, is the chief rice crop in Bengal. Experiments were commenced in 1901 on this crop and have been continued up to this year. The following have been carried out :—

A. MANURE—

(1) First series—Quantitative.

(2) Second series—Qualitative.

(3) Third series—Green-manuring.

B. VARIETY—

C. METHODS OF CULTIVATION—

(1) Implements—

(*a*) Sibpur Plough *vs.* Local Plough.

(*b*) Surat Bakhar *vs.* Local Plough.

(2) Sowing—

(*a*) Thick and thin sowing broadcast.

(*b*) Spacing in transplanting.

(*c*) Number of seedlings per hole in transplanting.

D. ROTATION WITH JUTE IN THE SAME YEAR.

Soil.—The soil of the Farm is a poor sandy loam. The following are analyses of average samples of the soil and subsoil of the Farm :—

	Soil 1st 9."	Subsoil. 2nd 9."
Insoluble silicates and sand	88·52	87·48
Ferric Oxide	3·60	3·68
Alumina	4·42	5·27
Lime	·34	·33
Magnesia	·34	31
Potash	·31	·32
Soda	·09	·07
Phosphoric acid	·02	·03
Sulphuric acid	·01	·005
Carbonic acid	·04	06
Organic matter and combined water ...	2·31	2·45
	100·00	100·00
Available Potash	·04	·02
Do. Phosphoric acid	·002	001
Do. Nitrogen	·011	·007

The figures denote that the land is exceedingly poor in nitrogen and phosphoric acid, poor in lime, but possibly contains enough potash.

Meteorology.—The following table gives the rainfall of the months from May to November, inclusive, from 1891 to 1906, inclusive :

1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906
13·98	3·92	21·84	4·65	5·40	6·93	7·47	0·82	3·16	6·03	4·77	6·50	3·94	6·75	9·52	6·08
2·85	10·73	11·17	8·77	11·39	17·14	11·26	18·92	11·51	8·04	6·42	6·94	8·98	8·79	1·57	5·19
14·00	7·94	15·17	13·49	8·47	7·06	11·53	8·31	24·03	7·79	11·04	9·59	9·81	14·13	34·14	12·30
15·54	3·48	4·56	10·52	4·87	10·18	14·77	16·45	10·19	8·79	8·26	7·65	14·15	8·83	14·80	17·68
1·82	6·81	12·91	5·14	7·96	9·33	8·34	13·32	8·96	17·55	8·77	6·91	7·96	3·62	10·23	13·58
0·48	3·92	5·16	3·89	3·70	*Nil.*	6·36	3·22	3·66	0·15	0·11	1·50	6·76	0·05	4·44	6·90
0·25	1·93	0·18	1·63	*Nil.*	*Nil.*	0·27	*Nil.*	*Nil.*	*Nil.*	3·16	0·09	1·20	0·01	*Nil.*	*Nil.*

The figures of this table denote that, when the rain falls fairly evenly throughout the month, a normal season for the paddy crop requires 10·17″ in June, 12·32″ in July, 11·49″ in August and 8·59″ in September. It is exceedingly important that the early rainfall should be sufficient to allow of transplanting by the middle of July, otherwise the outturn of the crop is very appreciably diminished. The date of transplanting

and the amount of rainfall in paddy cultivation are very important factors. This has been clearly demonstrated during the last three years. In 1904 the yield was diminished 30 per cent. through drought at flowering time. In 1905 the yield was again diminished 30 per cent. by the abnormal July rainfall of 34·14″ in contrast to an average of 12·32″ making transplanting impossible before August. In 1906 the outturn was diminished 50 per cent. owing to late transplanting in August due to the June rainfall being above 5″ below the normal and the inability of the canal authorities to supply water in July.

Experiments.

A. Manure.—Three series of manure experiments have been carried out, *viz.* :—

Series first.—Applying definite quantities of certain manures without any analysis.

Series second.—Applying the same manures in quantities calculated on analysis to supply 50lbs. nitrogen per acre (excepting bonemeal, which was taken to supply 30lbs. of nitrogen per acre).

Series third.—Green manuring.

Manures in kinds and quantities as stated below were employed. Patna paddy, a medium coarse variety, was employed in each series.

General treatment of the paddy crop.—The following treatment, which applies to all the experiments, was followed. The land was ploughed five times and harrowed twice to obtain the necessary condition for transplanting. Up to 1905 the land was allowed to lie after the paddy harvest till May before ploughing up. Since then the land was ploughed and cross-ploughed immediately after the harvest. Seed was sown in seed-beds in the first week of June and seedlings were transplanted in the first week of July when possible. The crop received one weeding and was harvested in the second week of December. Cowdung was spread in the second week of June, castor-cake and bonemeal in the third week of June, and saltpetre was applied as a

top-dressing three or four weeks after transplanting when the water had gone below the surface of the land.

Series I. Quantitative series :—

The object of this series is to ascertain the relative merits of cowdung, castor-cake, bonemeal by itself, and bonemeal together with saltpetre, as manures for Aman paddy. This experiment was commenced in 1891 and has been continued ever since. Manures were applied in definite quantities according to the following table which gives the average yields of grain and straw for the past sixteen years.

			Average yield in maunds (80 lbs.) per acre for 16 years (1881–1906, inclusive). Grain.	Straw.
Cowdung,	100 maunds	..	41⅕	55⅓
Unmanured		...	18⅗	28
Castor-cake,	6 maunds	...	36¾	55¼
Cowdung,	50 maunds	... ..	40⅕	55¾
Unmanured		... ...	19	32⅕
Bonemeal,	3 maunds	... ...	42	60⅓
Bonemeal,	6 maunds	... ...	45⅗	71⅕
Unmanured		...	20⅖	32⅘
Bonemeal,	3 maunds	... ...	} 50¾	73⅔
Saltpetre,	30 seers	..		

Hence the average outturn of the three unmanured plots for 16 years was 19⅕ maunds of grain and 32 maunds of straw per acre and the increase due to the manures was :—

			Grain. Mds	Straw. Mds. per acre.
Cowdung,	100 maunds	... ...	22	23⅓
Cowdung,	50 maunds	...	21	23¾
Bonemeal,	3 maunds	... ...	23	28⅓
Bonemeal,	6 maunds	... ...	26½	39⅕
Bonemeal,	3 maunds	... ...	} 31¾	41⅔
Saltpetre,	30 seers	... ..		
Castor-cake,	6 maunds	... ...	17¾	23¼

The results demonstrate that:—First, 50 maunds of cowdung gives almost the same outturn as 100 maunds. The small increase of outturn does not justify the application of the extra 50 maunds of cowdung. Second, 3 maunds of bonemeal is better than 6 maunds for the small extra yield obtained by the 6 maunds

is more than discounted by the cost of the extra 3 maunds. Third, an application of 30 seers of saltpetre as a top dressing in addition to the 3 maunds of bonemeal gives an increased yield over the bonemeal of $8\frac{3}{4}$ maunds of grain and $13\frac{1}{2}$ maunds of straw, an increase that repays many times over the cost of the $\frac{3}{4}$ maund of saltpetre. And fourth, castor-cake gives an increased yield of $17\frac{3}{4}$ maunds of grain plus $23\frac{1}{4}$ maunds of straw, and should not be forgotten by those who can obtain it at a cheap rate, or cannot procure the other manures.

Accordingly, the results of the experiment demonstrate first, the efficacy of 3 maunds of bonemeal plus 30 seers of saltpetre, and, second, 50 maunds of cowdung as manurial application per acre for paddy on such a soil.

The question of manures will ever remain the problem of the individual cultivator as it is the tendency of every piece of land to be different from its neighbour, and we cannot guarantee what has taken place in one area will also happen in another. Still it is very probable that in Bengal, owing to the few geological formations, fairly large areas of uniform composition are to be found, and the same manures should have the same effect on soils of a similar composition. The Burdwan Farm soil is very poor in phosphoric acid, lime and nitrogen. Bonemeal supplies chiefly the two former constituents while saltpetre supplies the last. Soils in the neighbourhood of the farm should be similarly affected by an application of bonemeal and saltpetre. Anyone can detect whether his soil is poor in lime or not. Let him take several samples of soil from his field, mix them together and pour on dilute hydrochloric acid. If no bubbles are given off, the soil is very poor in lime and available phosphoric acid and an application of manure is necessary. Let every cultivator try a small area for himself, and if satisfied with the results, he can increase the area the second year. Cowdung is a general manure and may be applied with benefit by every cultivator.

The following table gives the annual outturn of grain and straw for the past sixteen years :—

Manure applied per acre.	1891.		1892.		1893.		1894.		1895.		1896.		1897.		1898.		1899.		1900.		1901.		1902.		1903.		1904.		1905.		1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Cowdung, 100 maunds	50¼	61¾	46¼	58⅝	43¾	54¾	41½	53½	42	53½	40⅛	49¾	39	45⅛	39⅞	51⅜	40½	49	49¼	60¾	49	58⅛	49⅓	76½	49⅓	102⅛	29½	40	29⅝	43⅞	21	28½
Unmanured	19⅝	32½	15⅓	20⅓	16⅞	21½	16⅝	19½	16⅓	26⅛	15¼	27⅖	13¾	29⅓	17⅝	28⅖	22⅖	32⅞	17½	26½	17¼	36⅞	17½	33⅓	17½	39⅞	25⅓	31½	23⅓	28¾	17⅓	21
Castor-cake, 6 maunds ...	47¼	60½	42½	56⅞	41⅝	51½	39½	53½	40⅓	73	39¼	70⅞	38⅓	64¼	38	55½	34¼	42¾	34¼	52⅞	35⅓	55⅓	35⅞	57⅓	37	75	30⅓	42⅓	30½	43	23¾	29
Cowdung, 50 maunds	47½	57⅓	45½	58⅝	55⅓	71⅛	48	65½	47½	59[illegible]	47	60⅞	42	65⅓	48⅛	59½	39¾	45¼	34¼	45⅓	34½	52⅓	35⅓	55⅓	36½	74⅓	34¾	46⅓	31⅛	47⅓	23	28½
Unmanured	22⅖	33¾	15⅝	20¾	20⅓	41½	18¾	30⅓	18¾	29¼	18¼	28⅖	17⅓	48¾	19⅖	38⅛	18¼	26⅖	18	27¼	17¾	28	18⅛	28⅓	18⅛	36⅖	23¾	36¾	21¾	34⅝	17⅝	22¾
Bonemeal, 3 maunds ...	47⅖	59¾	46¾	67½	56⅓	78⅖	47¾	71½	48½	76⅓	17⅓	80	37⅛	60⅛	37⅖	55	37⅛	48¾	18	60¾	47	55½	47⅓	78⅓	48½	96	27⅖	35⅞	28⅛	34½	23½	29
Bonemeal, 6 maunds ...	48¾	59⅝	47¼	61½	46¾	72½	57⅖	78¼	56¾	102⅓	54¼	99⅛	45½	60	44½	55½	39¾	46¼	50⅖	62⅛	15½	63¼	51	65	51⅖	103⅓	31	40	30⅖	41⅛	23⅛	28
Unmanured	23⅖	34¾	18⅓	30¾	22¼	29⅖	19⅝	25¾	18⅞	25	77⅓	45⅞	18	36⅛	19⅞	36¾	19	26⅓	17⅓	29¾	18¾	30⅓	19⅓	30¾	19⅖	40	30¼	41⅓	28⅞	34⅞	18⅓	21
Bonemeal, 3 maunds ... Saltpetre, 30 seers ...	57⅞	69⅖	57⅞	63⅝	58⅖	78⅞	58⅖	79⅝	58⅛	104⅛	54⅞	104¼	48½	86⅛	48⅖	69⅓	43⅖	48⅓	57⅓	72⅖	57	74⅖	57⅓	75⅓	53⅞	108	36⅖	55⅝	38⅖	55⅝	24⅓	31½

The most striking feature about this table is the poor returns since 1903. In 1904 there was a decrease in outturn of 30 per cent. due to drought at flowering time in October. In 1905 there was again a decrease of 30 per cent. due to late transplanting owing to the July flood. In 1906 there was a decrease of 50 per cent. due to late transplanting owing to the June drought and the inability of the canal authorities to supply water in July.

MANURE EXPERIMENTS.

Second Series.—Manures analysed before application.

The scheme is to apply 50lbs. of nitrogen per acre in various forms, except in the case of bonemeal which is taken to supply 30lbs. of nitrogen only. Previously the amount of manure was calculated according to a standard composition of each, but since 1901-02 each manure has been analysed separately and the amount calculated accordingly. The following manures were tested: cowdung, bonemeal, bonemeal plus saltpetre, saltpetre alone and castor-cake. To supply the requisite amount of nitrogen the following quantities of manure were required, *viz.*:—$142\frac{1}{2}$ maunds of cowdung, $14\frac{3}{8}$ maunds of bonemeal. $14\frac{3}{8}$ maunds of bonemeal plus $2\frac{5}{8}$ maunds saltpetre.

The following table gives the average outturn for the past ten years :—

	Average yield per acre in maunds (80lbs.) Grain.	Straw.
Cowdung, $142\frac{1}{2}$ maunds	$34\frac{1}{3}$	66
Unmanured	$26\frac{1}{3}$	$48\frac{2}{3}$
Bonemeal, $14\frac{3}{8}$ maunds ... ... / Saltpetre, $2\frac{5}{8}$ maunds	37	$68\frac{1}{2}$ (The average of 3 plots.)
Bonemeal, $14\frac{3}{8}$ maunds	40	$73\frac{3}{4}$
Saltpetre, $6\frac{1}{4}$ maunds	$31\frac{3}{4}$	$61\frac{1}{8}$
Castor-cake, $10\frac{1}{2}$ maunds	$33\frac{1}{2}$	$61\frac{1}{4}$

The results are striking. In each case the manure gives an increase, but in no case is the extra increase commensurate with the amount of manure applied. So much manure has been applied that the unmanured plot is the most economical plot in

the series. The results corroborate those of series I, *viz.*, that (1) 3 maunds of bonemeal and 30 seers of saltpetre per acre, and (2) 50 maunds of cowdung per acre are the most economical manures to be given to the paddy crop for such a soil. Hence $142\frac{1}{2}$ maunds of cowdung or $14\frac{3}{8}$ maunds bonemeal plus $2\frac{5}{8}$ maunds saltpetre or $14\frac{3}{8}$ maunds bonemeal by itself or $6\frac{1}{4}$ maunds saltpetre or $10\frac{1}{2}$ maunds of castor-cake are too large quantities to be applied per acre as manure for paddy to such a soil. In other words, the net result of both series of experiments is that the paddy crop does not require so much manure as will supply 50lbs. of nitrogen as cowdung, bonemeal, saltpetre, bonemeal and saltpetre or castor-cake, but that from an economical standpoint about one-third of that amount or about 17lbs. of nitrogen per acre in the form of cowdung or bonemeal plus saltpetre is quite sufficient.

Seventeen pounds of nitrogen in cowdung and bonemeal plus saltpetre is represented approximately by 50 maunds of cowdung and 3 maunds, bonemeal plus 30 seers of saltpetre per acre, respectively.

Third Series. Green manuring.—San hemp and dhaincha, two leguminous crops, and jute, a non-leguminous crop, were green manured and compared with (1) 50 maunds of cowdung, and (2) an unmanured plot.

The following statement gives the average returns for jute, cowdung and unmanured plots for eleven years, san hemp for five years and dhaincha for four years :—

	Yield per acre in maunds (80lbs.)	
	Grain.	Straw.
Jute (green manured)	30	45
Cowdung	$26\frac{1}{2}$	$40\frac{1}{2}$
Unmanured	$16\frac{1}{3}$	28
San hemp (green manured)	23	$37\frac{1}{2}$
Dhaincha (green manured)	28	47

The piece of land on which this experiment has been carried out is very poor and this possibly accounts for the small outturn from the cowdung plot. The figures demonstrate forcibly that green manuring is a very economical method in the cultivation

of paddy. This should be especially remembered by those people who cannot obtain other manures. Jute (average of eleven years) ploughed in gives an increase of 14 maunds of grain plus 17 maunds of straw, while dhaincha (average of four years) gives an increase of 12 maunds of grain plus 19 maunds of straw. Jute, dhaincha and san hemp are sown in the end of May and ploughed under in July. The only extra cost of green manuring is the price of the seed which is very small, and two extra ploughings with one laddering to cover the crop properly.

B.—Variety Experiment.

Very little experimental work has been done on the subject of varieties of paddy. Their name is legion. To all those interested I would call attention to the late Mr. N. G. Mukherji's Catalogue of Exhibits of the Bengal Agricultural Department at the recent Indian Industrial and Agricultural Exhibition, 1906-07, from which an idea will be obtained of the vastness of the subject. He collected 1,182 named varieties for that occasion.

Out of all this chaos of kinds and varieties we are trying to get at something definite—at certain varieties that we can recommend to the cultivator as approved varieties.

The cultivator knows best what he wants to eat and he can be allowed to choose his own pet variety according as his appetite decides, but for market purposes there are certain varieties that always command higher prices and readier sale than others. We have tested eight of these varieties, *viz.* :—

Badshahbhog	(Bengal)	fine grained.
Kataribhog	do.	do.
Dadkhani	do.	do.
Banktulsi	do.	do.
Balam	do.	do.
Patna	do.	medium fine grained.
Sukhavel	(Bombay)	fine grained.
Kamod	do.	do.

They have all given fair results. Dadkhani has given consistent good results during the past five years and is well

worthy of notice. Kamod did excellently the first year but fell off a little every year afterwards.

C.—Methods of Cultivation Experiments.

(1) Implements:—

(*a*) Sibpur plough *vs.* Local plough.

(*b*) Surat Bakhar *vs.* Local plough.

(*a*) *Sibpur plough* vs. *Local plough.*

This experiment to compare the Sibpur plough with the local plough was commenced in 1894 and carried out for ten years. Except for the ploughs the same treatment was given throughout. The experiment was carried out in triplicate, each plot receiving a different manure. The following table gives the average yields of three plots for ten years:—

	Yields in maunds of 80 lbs.	
	Grain	Straw.
Local plough	... 25½	49
Sibpur plough	... 28½	52½

Hence the Sibpur plough gave a better outturn by 3 maunds of grain plus 3½ maunds of straw than the local plough.

(*b*) *Surat Bakhar* vs. *Local Plough.*

For the past three years these two implements have been compared in the preparation of the paddy transplanting bed and results are in favour of the local plough.

(2) Sowing experiments:—

(*a*) Quantity of seed in broadcast cultivation.

(*b*) Spacing in transplanting.

(*c*) Numbers of seedlings per hole in transplanting.

(*a*) *Quantity of seed in broadcast cultivation.*

Seed was sown broadcast on the land as is the custom in some districts and three different seed rates were compared, *viz.*, 60lbs., 30lbs. and 20lbs. per acre. Cowdung to supply 50lbs.

of nitrogen per acre was applied. The land was ploughed six times and laddered once. Seed of fine grained paddy *Badshabhog* was sown broadcast in the above quantities and the after-treatment consisted of two weedings. The following table gives the results of the last three years :—

Quantity of seed sown broadcast per acre.	OUTTURN PER ACRE, 1904.		OUTTURN PER ACRE, 1905.		OUTTURN PER ACRE, 1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
60 lbs. per acre	34·1	54·9	35·5	58·5	10·2	20·4
30 ,, ,, ...	28·3	51·3	36·5	52·1	17·2	20·4
20 ,, ,, ...	32·7	51·3	34·1	56·1	17·5	20·4

The results show that there is no need to sow more than 30lbs. of seed per acre, in the broadcast cultivation of paddy.

(*b*) *Spacing in transplanting of seedlings.*

Seedlings transplanted 9", 12", 15" and 18" apart were compared. Cowdung at the rate of 100 mds. per acre was applied. Seed time, transplantation, fore and after treatment of the crop are the same as that described in the manure experiment. The same number of seedlings was transplanted in each hole.

The following are the results for 1904, 1905 and 1906 :

Degree of spacing in inches each way.	OUTTURN PER ACRE, 1904.		OUTTURN PER ACRE, 1905.		OUTTURN PER ACRE, 1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
Seedlings transplanted 9" apart	28·8	57·0	29·7	45·5	22·6	28·1
,, ,, 12" ,,	30·9	43·1	28·4	41·4	23·4	28·1
,, ,, 15" ,,	28·6	52·0	28·3	50·5	21·0	25·6
,, ,, 18" ,,	26·9	32·0	24·2	36·8	18·7	20·4

The results show that 9" to 12" is the best distance apart to transplant paddy seedlings.

(*c*) *Different numbers of seedlings per hole in transplantation.*

One, two and four seedlings per hole were compared. The distance apart of 12" was taken. Treatment, fore and after

cultivation were exactly like the preceding experiment (2). Below are given the results for the past three years—

Number of seedlings per hole and distance apart each way.	Outturn per maund.					
	1904.		1905.		1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
1. One seedling per hole 12″ apart	34·8	48·2	28·1	38.9	13	22
2. Two seedlings „ 12″ „	30·7	42·4	23·0	37·3	13	18
3. Four „ „ 12″ „	26·0	36·5	30·0	45·0	13·5	18

The results demonstrate that there is no need to transplant more than one seedling per hole.

D.—Jute in Rotation with Aman Paddy.

This experiment of taking off a crop of jute from the land before transplanting the paddy was commenced in 1905. Jute was sown in the beginning of May and harvested in the beginning of August, while the paddy was transplanted in the third week of August and harvested in December. To prepare the jute seed-bed, eight ploughings and three ladderings were necessary while the crop was raked (bidared) thrice, thinned once and weeded twice. After jute harvest the land was ploughed thrice and laddered (harrowed) once to prepare the transplanting bed for paddy, while the after cultivation of the paddy crop consisted of one weeding, one hoeing and one watering.

In 1905, $15\frac{1}{2}$ mds. of grain plus $19\frac{1}{2}$ mds. of straw (fine variety) was obtained, while in 1906, 18 mds. grain plus 22 mds. of straw (coarse variety) was obtained :

Crops.	1905.		1906.	
	Yield per acre in maunds.		Yield per acre in maunds.	
	Grain.	Fibre or straw.	Grain.	Fibre or straw.
Jute ...	...	16	18	$17\frac{4}{5}$
Paddy (coarse) ...	$15\frac{1}{10}$	$19\frac{3}{5}$		22
Jute ...	......	......	$12\frac{4}{5}$	$17\frac{3}{5}$
Paddy (fine)	...	......		19

In 1905 meteorological conditions were not favourable to a good paddy crop. In July the abnormal amount of 37·32″ of

rain was recorded, in contrast to an average of 12·32″ for the district, while 3″ more than the normal rainfall was recorded in August and September. This caused very unfavourable growing conditions for the paddy crop before September. A yield of 16 mds. of jute followed by an outturn of $15\frac{7}{10}$ mds. of paddy grain plus $19\frac{3}{5}$ mds. of straw is, therefore, very reassuring.

In 1906 no rain fell in April, and as the canal was unable to supply water, the jute sowing was three weeks late. Hence the jute harvest was retarded and the growing period of the paddy crop was shortened by three weeks. The return of $17\frac{3}{5}$ maunds of jute followed by 18 mds. of grain plus 22 mds. of straw from a coarse variety of paddy, and $12\frac{4}{5}$ mds. of grain plus 19 mds. of straw from a fine variety of paddy are very satisfactory.

The following table gives full details of the experiment in both years:

Crop.	Quantity of manure applied per acre.	Date of planting.	Date of harvesting.	Outturn per acre in maunds.	
				Grain.	Straw or fibre.
1905.					
Jute ...	Cowdung, 5 tons	1st May 1905 ...	20th July 1905	...	16
Paddy (coarse) ...	No manure ...	3rd Aug. ,,	4th Dec. ,,	$15\frac{7}{10}$	$19\frac{3}{5}$
1906.					
Jute ...	Unmanured	10th May 1906	3rd Aug. 1906	...	$17\frac{3}{5}$
Paddy (coarse) ...	Saltpetre, 30 seers.	18th Aug. ,,	5th Dec. ,,	18	22
1906.					
Jute ...	Unmanured	10th May 1906	3rd Aug. 1906	...	$17\frac{3}{5}$
Paddy (fine) ...	Saltpetre, 30 seers.	18th Aug. ,,	5th Dec. ,,	$12\frac{4}{5}$	19

1905.—In this year, $\frac{1}{10}$ acre plots were taken. These plots had for the previous five years only grown jute each year. Cowdung at the rate of 5 tons per acre was applied to the land before the last ploughing in the preparation of the jute seed-bed, and the paddy crop received no manure.

1906.—In 1906, four $\frac{1}{2}$ acre plots were taken on land that had previously grown sugar-cane. No manure was applied to the land for the jute crop, but the paddy crop was top-dressed with 30 seers of saltpetre per acre.

The following statement shows the economic result of the experiment in 1906:

Crop.	Yield per acre. Grain.	Yield per acre. Fibre or straw.	Cost of cultivation.	Money value of outturn.	Profit. Per acre, each crop.	Profit. Total, per acre.
	Mds.	Mds.	Rs. A.	Rs. A.	Rs. A.	Rs. A.
Jute ...		17½	52 6	179 7	127 1	...
Coarse Paddy	18	22	35 1	57 3	22 2	149 2
Average of 79, 80 and 81, 3 plots. Jute		17½	56 13	180 12	123 15	...
Average of 79, 80 and 81, 3 plots. Fine Paddy	12½	19	36 0	64 13	28 13	152 12

These figures do away entirely with the idea that if the area of jute cultivation is increased, the people's food-supply will be imperilled, for not only is the raiyat's food-supply assured by the paddy crop, but in the same year a crop of jute is obtained from the same land and this extra crop will enable the cultivator to obtain other necessities of life than those ensured by the paddy crop. A net profit of Rs. 150 per acre is well worthy of a farmer's consideration.

In connection with this experiment and since the above figures were published, I have received the following interesting information. N. D. Beatson Bell, Esq., I.C.S., C.I.E., Director of Land Records, Eastern Bengal and Assam, writes:—"The following figures are taken from the Settlement Records in a few Estates in the Rungpur District:—

Name of Estates.	Area in acres under jute.	Area in which jute was followed by Winter rice.	Other food crops.	Non-food crops.	No crops.
		Acres.	Acres.	Acres.	Acres.
Panga	2,873	1,165	373	6	1,529
Kaya	2,493	1,142	938	...	413
Chatmai	1,444	757	283	...	404
Total	6,810	3,064	1,594	6	2,146

The above figures denote that in these estates 45 per cent. of the land that grows jute grows also a crop of paddy the same year.

These figures demonstrate without a doubt the practicability of the above experiment.

I would only add the following advice to cultivators in the Burdwan Division before finishing, *viz.* :—"If you want a good crop of paddy, get your jute sown as early as possible so that the crop may be cut early enough to allow of the transplanting of paddy in July and give a good dressing of manure to the jute crop as well as a top-dressing of soluble manure to the paddy crop."

THE IMPROVEMENT OF COTTON IN SIND

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THE experiments with this object in view may be said to date from 1846 when Major Golding, then Collector of Shikarpur, tried Sea Island in the Rohri Districts. The results obtained by that gentleman were not encouraging, for the produce obtained amounted to only $18\frac{1}{2}$ seers of seed cotton per acre. Subsequently, experiments were made from time to time by officers of the Revenue Department as well as by the Forest authorities.

In 1852 Sir Bartle Frere who was Commissioner in Sind at that time came to the conclusion that no definite or useful results were likely to be obtained from such experiments, and he suggested that some practical and intelligent man should be appointed to devote himself actively and entirely to this object. Accordingly an American cotton planter, Mr. T. G. Prince, who had been engaged in cotton cultivation at Coimbatore, was appointed to superintend cotton experiments in Sind. Mr. Prince on his arrival in Sind made a tour through the Province and observed in his report "the plants I saw, both Egyptian and New Orleans, had with very few exceptions grown luxuriantly in every part of the country where only an ordinary degree of care had been bestowed, but only the New Orleans had yielded cotton." Mr. Prince held his appointment for three years till 1855 when he died. He appears to have been singularly unfortunate in his work, for it is reported that his attempts to grow Egyptian cotton in Sind were an unbroken record of failure, and from one cause or another there was not a single instance

of success. After this Sir Bartle Frere abolished the experimental establishment and no further efforts in this direction were made until 1860, when the Bombay Chamber of Commerce, by the direction of the Manchester Cotton Supply Association, forwarded five bags of Egyptian cotton seed to the Commissioner in Sind for experimental cultivation in the Province.

Of the experiments with this seed the most successful result was obtained at Rattadera in Larkhana, where the produce amounted to 480lbs. of seed cotton per acre. None of the trials made in other parts of the Province appear to have resulted in the production of any cotton at all and even in the Rattadera case, there was some doubt whether the cotton was really the produce of Egyptian plants for the staple was extremely short. This cotton was valued by the Bombay Chamber of Commerce at from $5\frac{1}{4}d.$ to $5\frac{3}{8}d.$, whilst at the same time middling Egyptian was worth $8\frac{1}{4}d.$ per pound. Little more was done during the succeeding years, but there was a revival of interest in this question about 1867.

Mr. Hughes, Cotton Inspector in Sind, initiated some experiments in 1868 at the Malir Farm, and these were continued by Mr. Strachan the following year. About this time a Model Farm was started at a place called Salura near Hala in the Hyderabad District, and Mr. Strachan transferred his experiments to this place in 1870. The farm was situated in one of the best cotton growing tracts in Sind and experiments were carried on more or less continuously till 1879 when Mr. Strachan was transferred to Hyderabad. The experiments were continued in the Economic Garden of Hyderabad till 1889. During all these years Mr. Strachan experimented with a great number of varieties of cotton, of which the following list is a record :—

LIST OF COTTON VARIETIES.

Peruvian, Egyptian, Bourbon, Hinganghat, Dharwar, Nankin, Sea Island, American, Broach, Baburich, Dharwar-American and Sind (Indigenous).

The best results were obtained with American (New Orleans) and Nankin, but even from these the returns obtained were not equal to the yield of Sindhi cotton.

The report of these experiments shows that the yield obtained per acre was very low.

In 1869-70 the yield of Egyptian cotton was only 80lbs. of seed cotton. It was further remarked in 1870-71 that the Egyptian variety seemed to suffer from very slight variation in the weather and eventually succumbed to the frosts of January.

In the year 1871-72 experiments were conducted in growing Egyptian and other varieties of cotton on ridges, but the conclusions come to were: "Egyptian turned out badly although up to the time of harvest the plants were as good as any one could wish them to be: they also flowered well and set plenty of bolls which, however, were badly attacked by boll-worms and then by a small bug-like fly which also took possession of any healthy bolls and discoloured the cotton slightly."

Further experiments in ridge planting were made in 1873-74, but the yield was practically nil, and Mr. Strachan in his remarks states, "of the two methods of planting the plants succeed best when sown in lines on the flat." Again Mr. Strachan in summarising his opinion upon the subject of introducing Egyptian cotton into Sind, says, "I am sorry that neither the reports of experiments made in this line before I had seen India nor the experience I gained during the nearly 21 years I was employed in trying to introduce new kinds of cotton or improve the Native variety, permit me to offer even the shadow of a hope that the Egyptian variety of cotton will be successfully grown as a crop that will pay in this Province. I was, when I first took these experiments in hand, very hopeful of succeeding with the Egyptian variety, but failure year after year led me to question the correctness of what I had heard and read about the soil and climate of Egypt and Sind being so much the same and that it was an almost certain thing the Egyptian would be just the very plant to suit both its soils and climate. That the Egyptian plant and the soil of Sind suit each other, I still believe. It

is in my opinion the climate which stands in the way of success and forms an unsurmountable barrier to any undertaking in the way of growing it in this Province. The climate of Egypt must differ considerably from that of Sind, it is bounded on two sides by salt water, while very little of Sind touches the Sea and that portion of it which does so is but little suited for cotton growing. In describing the climate of Egypt, Samuel Smith in a letter on the cotton trade of Egypt published in 1883 says of its climate, 'for eight months of the year it is cool and delightful and the summer months far from unhealthy. It has indeed one of the most salubrious climates in the world.' My experience of the climate of Sind would lead me to give it a rather different character, and I may add that I doubt whether any of the chief cotton growing districts in India can justly claim a description of climate similar to that just quoted. At any rate if the Egyptian cotton plant will succeed only in such a climate, Sind is not the place for it, though its climate be not the worse possible one could select to grow cotton or live in."

Again Mr. Strachan remarks that the flowers are usually numerous and healthy and the pods show no symptom of ill-health till a little before the time when they should begin to open, then they begin to shrivel and fall to the ground and the few capsules which do give cotton are seldom healthy looking. The only place in Sind where Mr. Strachan thought Egyptian cotton might succeed was the Shahbander or Tatta District of Lower Sind, where the land is good and the sea breeze is felt.

More recently experiments were carried out on the Municipal Sewage Farm at Karachi at the request of Mr. Jamsetjee N. Tata, of Bombay, who revived the interest in this question by a memorandum on the growth of Egyptian cotton in India, which he published some ten years ago. In this memo. Mr. Tata strongly urged further experiments and in response to his request a trial was started on the Sewage Farm at Karachi in 1896. Mr. Tata suggested that the Egyptian cotton should be tried as a *rabi* crop because climatic conditions during the eight months from October to May in Sind corresponded closely to

those prevalent in Egypt, from March to October, the period when cotton is grown in that country. Mr. Strachan, who was in charge of the farm and who was still experimenting with different varieties of cotton, conducted the experiment, but I have no information as to the results. However, it may be pretty safely assumed that the experiments were not attended with success, for in that case more would have been heard of the enterprise.

Some six years ago Messrs. Ralli Brothers drew the attention of the Commissioner in Sind to the fact that the best cotton produced in that Province strongly resembled Assam and Comilla cotton, but was inferior to these. Comilla cotton possesses a short staple and a rough harsh lint and is in considerable demand on the continent of Europe for mixing with wool in the manufacture of certain kinds of cloth.

The idea, therefore, occurred to Messrs. Ralli Brothers that the cultivation of this class of cotton would be of mutual advantage both to the cultivator and the exporter, for Comilla cotton commands a price of Re. 1-8-0 per maund above that of the indigenous Sind variety.

With the co-operation of the Commissioner in Sind arrangements were made for the experimental cultivation of this cotton and the first consignment of seed arrived in time to be sown in the *kharif* of 1900. The experiments were conducted by the Revenue officers at Mirpurkhas, Umerkot, Sinjhero, Khipro, Hala and Shahadadpur, but unfortunately little success rewarded these efforts. Renewed trials were made the following year, but with perhaps one exception no success was obtained. Many explanations were advanced to account for these failures. In some cases the seed did not germinate, in others the land was said to be bad, while yet in others the blame was laid upon the injuries done by insects and hot winds. In the case of Mirpurkhas the Mukhtyarkar sowed 2½ acres with Comilla seed and obtained 7 maunds 7 seers of seed cotton. This was a small yield, but there were several causes to explain it. The seed was sown very late on sandy land possessing much *kallar*. Insects did considerable damage and

many *phutties* failed to mature owing to the late period at which the seed was sown.

Messrs. Ralli Brothers expressed the opinion that the cotton grown in 1900 showed very satisfactory quality, the *phutties* being of unusually large size and the cotton being white and rough. In 1902 the same firm considered the Comilla much the better of the two varieties tried, but they were dissatisfied with the colour of the lint which left much to be desired in the matter of whiteness. It was considered that this defect was due to old seed having been sown.

In 1903 Mr. MacKenzie, Deputy Commissioner of Thar and Parkar, imported 100 maunds of Comilla seed and distributed it along with the seed produced by the previous year's crop among the Zamindars of his district. He also sowed some himself at Mirpurkhas. Unfortunately heavy rain, when the plants were at a tender age, did great damage. The Mukhtyarkar resowed the land partly with the previous year's seed and partly with new seed. This, of course, spoiled the experiment, for one of the chief objects was to ascertain whether the quality of the lint deteriorated when grown in Sind. Moreover, the new seed proved very unsatisfactory, producing very small *phutties* and quite unlike those obtained in previous years. This led Mr. MacKenzie to the conclusion that either wrong seed had been supplied or, if not, then the seed must have been very bad. No further attempts were made to introduce this variety.

It will thus be gathered from the above remarks that up to the year 1903 no success had rewarded the many efforts which had been made with the object of improving the cotton of Sind. However, in December of that year Mr. Fletcher, who had recently taken up the duties of Deputy Director of Agriculture in the Presidency of Bombay, made a tour through this Province, and was much struck by the great similarity of the conditions of the country to those prevailing in Egypt. Unlike Mr. Strachan, Mr. Fletcher possessed personal knowledge of Egypt and its agricultural practices, and he at once saw the great possibilities which might follow upon carefully conducted experiments with

Egyptian cotton. Mr. Fletcher was confirmed in this opinion when on a visit to the Deputy Commissioner of Thar and Parkar, he noticed some Egyptian plants growing luxuriantly in that gentleman's garden.

Accordingly experiments were set on foot first at Dhoro Naro and afterwards at Mirpurkhas. Very satisfactory results were obtained and in the following year seed was distributed to the Zamindars on the Jamrao Canal sufficient to sow 1,500 acres. Agriculturally the cotton proved a great success, but unfortunately the prices obtained fell far below expectations. This, however, may be ascribed purely to the fact that hitherto there had been no supply of this class of cotton and consequently no appreciation and no demand.

Arrangements were made for 6,000 acres to be put under this crop in the current year, and the Government of Bombay have voted Rs. 5,000 and made special arrangements to secure a satisfactory market for the produce. Thus, after 60 years of experiment and trial the object aimed at seems at last to have been attained. It yet remains, however, to be proved whether the quality of the lint will maintain its high character in the cotton markets of the world.

PRACTICAL REMEDIES FOR INSECT PESTS.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

THE ultimate aim of the study of destructive insects is the discovery of some feasible method, whereby their increase and destructiveness may be checked and crops preserved from their attacks. In such a quest, not only must the habits and characteristics of each individual pest be considered, but it is of equal importance to take into account the conditions under which the crop is grown and the facilities there are for adopting any method of repression. It is probable that in India, the scientific methods that appeal to the skilled farmer of European countries will be of little value when applied to the conditions of Indian Agriculture and the best methods that science reveals can scarcely be regarded as suitable to the present problem. In very many cases, the habits of a pest are such that practically nothing is possible unless we can utilise the most up-to-date and artificial methods. In others, a weak point can be found in the life of the pest when it can be successfully attacked by some very simple means. Given some such simple remedy, thorough co-operation in its application over some area is usually also necessary, and this is perhaps to be obtained only when an unusual abundance of a pest awakes the ryot to the necessity of some action and, with a little pressure, a fair trial can be given to the remedy. Experience has shown that, for some pests, there are such simple remedies as can be applied by an individual cultivator, and it is chiefly these I propose to discuss here.

An instance that has already been discussed in these pages (Vol. I, p. 58), is the very simple method of checking the stem borer of cotton, where the withered plants which contain the

pest can be removed and burnt with the pest in. The emerging beetle is not a wide-ranging insect and is apt to confine its ravages to a small area: the destruction of the withered plants in a cotton plot does much to protect that particular plot, and though joint action over a large area would be far more effective, even a small plot may be largely protected.

The red bug of cotton is a pest that yields to the simplest of all methods, destruction by hand; so also the very common dusky bug, which often swarms in cotton bolls, can be checked by the simple precaution of removing all the bolls that are worthless at the same time as the round ripe bolls are plucked. It is unfortunately a general practice to leave on the plant those bolls which have been so damaged by bollworm as to be not worth plucking: the dusky bug finds there a secure breeding place where it may lay its eggs, and where its young can obtain food from the uninjured seeds: from these breeding places it spreads to other bolls and in them it sucks the seeds, rendering them useless for sowing or oil-extraction. The removal of all such bolls is a simple and effective means of preventing the feeding of this pest. In cases where dusky bug is very abundant, a further simple method is valuable: the bug collects in the bolls in great numbers and, when disturbed, runs out and falls to the ground. The greater number of these can be destroyed by tapping the boll while a pot of water with a film of kerosene over is held below the boll; practically all the bugs fall into the water and are killed, and an infested field can be very rapidly cleared.

Among the minor pests of cotton that are occasionally very injurious is the leaf roller, a green caterpillar that rolls up the leaf into a funnel and lives inside. This pest commences when the cotton (if sown with the first rain) is about a month old: the rolled up leaf is very characteristic and an infested plant has a peculiar appearance due to the unnatural position of these leaves. Every one of these leaves can be picked off with the caterpillar in and if the work is done early, the first brood can be so thoroughly checked that very little remains to be done. If the first brood is missed, the increase is so great that a vigorous crop will be

completely stripped later in the season, and it then becomes a far harder task. Were labour an expensive item, spraying with an arsenical poison would be the simple remedy, and both have been in use on the Pusa Experimental Farm. As it is, we have here a case that particularly applies to our conditions, one that is within the reach of any cultivator or zamindar.

A pest that is constantly reported from cane-growing districts is the Moth-borer; this pest was discussed in a previous number of the Journal (page 97, Vol. I, Pt. ii) and the principal remedy for it is to cut out and remove all the shoots which die in the young canes and which have the insect in them. In many juar-growing districts, especially in the Central Provinces and Bombay Presidency, this hibernates in juar and the caterpillar is constantly found in the stumps left in the ground after the crop is cut. The removal of these stumps is a very valuable remedy, since it removes the pest when it has no other refuge and destroys the insects that would otherwise do much harm later in the season. This is a practical measure well worth impressing on cultivators; they know the insect, they can be shown it in the juar stump, and though they do not understand its transformation, yet they are open to the commonsense suggestion that these insects will increase later on and attack their crop. Most of these remedies are pure commonsense, and if we could find such weak points in the life of every pest, we would be able to deal more effectively with the problem. Apart from their value as remedies, they are valuable also as demonstrations; if a start can be made by demonstrating such simple remedies, and the ryot can be induced to take them up at times when the losses from the pest are fresh in his mind, the foundation for further work in checking preventible loss will be laid. It is astounding how universally the simplest remedies are unthought of by the cultivator, apparently because the question of checking pests never suggests itself until the overwhelming numbers of a caterpillar or grasshopper make a practical remedy an impossibility. In very many cases, if the possibility of checking the insect was known to the ryot, he would, from his own intimate knowledge of his crops,

be able to prevent or check much of the loss that constantly occurs.

A case in point is the brinjal crop, a paying vegetable crop grown for long periods on land that can be irrigated, to supply a local market. This plant is destroyed by a caterpillar that tunnels in the stem and that sooner or later so interferes with the upward flow of sap that the plant suddenly withers: the cultivator then pulls up that plant and, if not too late, puts in a young one from which he may hope to get a small yield. The withered plant he lays somewhere near by, with the borer in: this presently transforms and emerges to lay eggs in large numbers on other plants. Had the cultivator burnt his plants from the very first, plucking them out regularly as they withered, he would have prevented the very large loss in the later growth of the crop, a loss that often means a great reduction in the yield of the field.

Til is a crop from which two pests are very commonly reported: one is a large green caterpillar, with bright oblique stripes on its side, and a curved horn at the hind end. It grows to a length of three inches and is very conspicuous. The other is a small caterpillar, creamy green, with little black specks, which rolls the leaf and bores in the capsules. Both yield to the same treatment, destruction by hand *when they first commence*: the smaller caterpillar especially is checked by this treatment as its life is short, it multiplies very rapidly and it often is very injurious to the seed capsules as the crop ripens. In this case again, it is cheaper and equally effective to remove by hand as to spray with an arsenical poison.

A familiar pest to cultivators in some parts of India is the common white ant: investigation up to the present shows that the destructive white ant of the plains is one species only: in some parts of the country it nests below ground, in others at the surface or it builds up mounds above the surface of the soil. Where the termites nest deeply as in the deep alluvial soils of the Gangetic and Indus plains, practical means of checking termites are difficult to find; but where they nest at the surface, a great deal can be done to check them by the systematic destruction of

the nests: the simplest method is to dig into the nest and pour in abundant boiling water: the sign of success is when the very large white queens are obtained as they are found only in the nest itself, and if these are destroyed with as many of the smaller termites as possible, the termites cannot increase until they build up a new nest and rear a fresh queen. In some parts of India, there is little reason why any termite nest should be allowed to remain and a little systematic effort by each village would keep the land practically free of this destructive insect.

Another common pest is the weevil whose grub tunnels in sweet potatoes, rendering them wholly unfit for food. We have seen fields, where a crop had been dug, covered with potatoes which were thoroughly infested and left to breed weevils, thus providing a plentiful supply of insects to infest other fields or the next crop. This might readily be avoided if these potatoes were gathered and buried in a pit under a foot of hard trodden soil. It is only pure commonsense to take such a precaution and so prevent the multiplication of the insect to attack next crop.

For some pests the bag and frame so extensively used in the destruction of the hoppers of the Bombay Locust is a practical method. The surface grasshoppers do a very large amount of damage yearly in the young crops, especially in the germinating *rabi* crops. These are flattened insects, white below, with the upper surface roughened and earthy colour; they abound in the fields and hop up as one walks along. If a wide bag on a frame is run through the field fairly rapidly, the grasshopper, as it jumps up, is caught by the bag and swept up. At the end of each run the bag is twisted up and the insects shaken into a corner and destroyed. In this way a large area can be rapidly and thoroughly cleared, either before the crop is up or while the plants are still young. The cost of a bag and frame is small, as it is all made on the spot and it should not exceed three rupees. In the case of tobacco, it is very necessary to clear the land of the grasshoppers before setting out the plants. In Pusa we dip all such seedlings in Lead Arseniate Wash and so render them

immune, but the bag, if used before the plants are set out, has the same effect.

The bag in its various forms is useful in many cases when its application is once understood, and it provides the most practical remedy against a fairly universal pest of rice, the Rice Bug. This is a slender green insect, which flies readily when full grown; it emits the usual aromatic odour of its class and an infested field may often be known by that alone. As the rice comes into ear, the bugs assemble there and suck out the milky juice in the developing grain. The grain then whitens and the ear has nothing in when it comes to harvest. A light bag, 8 feet wide, run rapidly through the field, brushing the tops of the rice sweeps up these bugs and though some escape, the bulk are captured. A bag must be used as the insects escape from a plain cloth or *dhotie* unless it is smeared with sticky matter: the bag is considerably more effective if first soaked in kerosene or in an emulsion made by shaking up kerosene with sour milk. This method like the others mentioned above is in application on the Pusa Farm, where ordinary coolie labour is employed: as soon as the bug is found, the bag is used and there is no difficulty in checking this pest.

Rice is constantly attacked by another class of pest, which yields to simple treatment if that treatment is carried out over any area larger than a few acres: this pest is the stem-borer, a caterpillar which eats up the centre of the growing shoot of rice and kills it: the result is that each shoot withers, and as a single caterpillar in many cases attacks several shoots, the damage to the ripening crop is considerable. This form of damage is reported from practically every rice-growing tract in India: several insects are concerned, which are all quick breeders, and of which two or three broods complete their life-history in one crop; for all these there is but one practical cure: that is, to pick them all out from the beginning: if the cultivator would learn that withered rice shoots contain a caterpillar which, if left alone, breeds and multiplies quite naturally, he might systematically pick out and burn all withered shoots: these are

sufficiently easy to see and it does not require much time or labour to go over some acres of paddy. Were this known to the cultivator and were he to do it, we believe that no cases of destruction by these pests would ever be seen. In some cases, it is possible also to utilize another method, depending upon the fact that, like the moth-borer of cane, the stem-borer of rice spends the cold weather or hot weather when the crop is not growing in the stubble: where this stubble can be taken out and destroyed, it destroys those insects which live over until the next crop and then emerge to breed. How far the destruction of rice stubble is possible depends upon local conditions, but it is always a valuable safeguard.

A common and widespread pest is the surface caterpillar, a dark-coloured smooth caterpillar, over one inch long, which lives by day in the soil, emerging at night to wander about and cut off young plants for its food. This insect can be easily collected by hand, its burrows being revealed by the green leaves which it has consumed: as a rule, it lies hidden near the plant it has cut off, often at its base, and it is readily found with the hand hoe (kurpi).

It is perhaps needless to multiply instances of this, the simplest of all methods. For very many pests, the remedy is there to hand, namely, to destroy the insects when they first appear and so to save the later destruction caused by their natural increase. We have cited cases enough to show that, in very many instances, there are simple methods by which the cultivator could materially lessen the losses caused to his crop by insects. It is perhaps needless to say that there are other cases where equally simple remedies could be devised *by the cultivator*, if he knew how his pests lived and multiplied: in most cases, the scientific study of an injurious insect shows what its weak points are, but to take advantage of them requires also a very thorough knowledge of local agriculture which no one person can have for more than a limited area; the treatment of such pests must be a matter for the future, but there seems to be no reason why efforts should not now be made to bring home to the cultivator

the facts regarding such simple pests as it is possible for him to cure, and thereby to open his mind to the realisation of the fact that, the knowledge of the pest's life-history is the first essential, and that, given that, it is often within his scope to devise some means of circumventing the enemy. The cases enumerated above are cited as being those in which there exists a simple practical remedy for a particular pest: if the cultivator can be induced to adopt one of these and so to lessen the damage to his crop in any one case, a great step forward will have been made.

THE GOVERNMENT CATTLE FARM, HISSAR, PUNJAB.

By Colonel J. W. A. MORGAN, M.R.C.V.S.,

Inspector-General, Civil Veterinary Department in India.

The chief object of this article is to offer some advice regarding the breeding of some farm animals in India. I give first a short account of the Hissar Farm—the premier Cattle Farm of India—in order that those who are concerned with cattle breeding may know something of its failures and successes.

This Farm was established in 1809 for camel breeding. The breeding of cattle and horses was added in 1815. In 1853 it was decided to restrict operations to breeding bullocks for artillery and ordnance purposes, the management being transferred from the Commissariat to the Stud Department. In 1874, at the instance of the Stud Commission, it was again transferred to the Commissariat Department. Since 1898, the Civil Veterinary Department has had charge of the Farm. If a definite policy had been framed from the beginning and adhered to, the Farm would have been of much greater advantage to the country than it has been. The breeding of improved stock is a matter of years, in which it is difficult to rectify any error; therefore, definite aims should be kept prominently in view from the start. The objects of the Hissar Farm were varied at comparatively short intervals up to recent years so that there was not time to achieve real success in any. Since the Farm was taken over by my Department, clearly defined lines of work have been laid down and followed.

The annual average rainfall at Hissar is small—considerably less than it was at one time—the grass lands are extensive, but in years of deficient rainfall they cannot be relied upon except to give very scanty grazing. Therefore, a considerable area of

PLATE XXX

A.J.I.

HARRIANA BULL AT HISSAR FARM.

PLATE XXXI

I.J.I.

HARRIANA COW AT HISSAR FARM.

irrigated land is devoted to the cultivation of fodder crops. These are of various kinds but are chiefly sorghums. They yield very heavily as the arable land is naturally fertile and is heavily manured with cattle dung from the breeding herds. The fodder from the irrigated area is stored dry in stacks or as ensilage in pits.

The annual output of stock from the Farm is estimated at 250 Siege Trained Bullocks, 100 Bulls for district work, 100 Mules for ordnance purposes and 25 to 50 Donkey Stallions for mule breeding in the districts.

To meet this output, it is necessary to maintain on the Farm :

Herd bulls	20
Breeding cows	1,500
Young stock	1,100
Donkey stallions	6
Donkey brood mares	80
Brood mares	200
Mules	400
Cultivation bullocks	250

Each kind of this list is believed to be suited to the Hissar District and many other parts of Northern India. The types will be strictly adhered to, and improved by selection. The best only will be retained on the Farm for brood purposes.

Before starting a Government Cattle Farm in any Province in India a general survey is required to determine (*a*) whether the particular district of the proposed Farm is usually free from famine and whether in ordinary years drinking-water and fodder are sufficient or abundant : (*b*) how fodder supplies can be improved in an economical way : (*c*) whether the best of the local cattle are true to a particular type and whether attempts at improvement are likely to succeed : if not, whether a better breed imported from another Indian district is likely to thrive under local conditions ; (*d*) the means which should be adopted to rear and distribute bulls for the general improvement of the cattle of the district : (*e*) the value of local fairs and shows to encourage the breeding and sale of good animals : (*f*) whether young cattle, for work

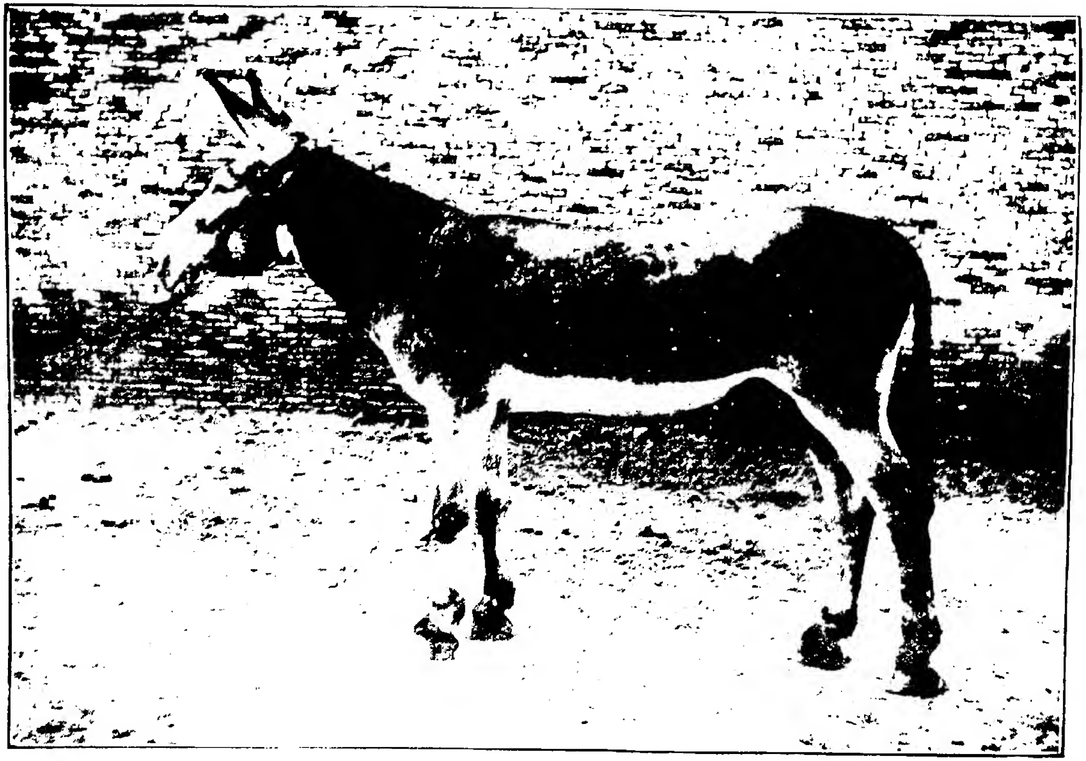
purposes, are imported into the district. If so, where do they come from and why is such importation necessary? (*g*) whether contagious or other diseases are common.

Having gathered the foregoing information, it is possible to determine whether a Government Cattle Breeding Farm can be successfully established in the particular tract or not.

Some parts of India are quite unfitted or only partially suited from climatic and other conditions for the breeding of cattle. The requirements of these parts are now met by importations from more favoured regions. In other parts of India, the cattle breeding industry is already carried on so successfully that there is no need for assistance from Government Farms. It is quite unnecessary for Government to compete with really good private enterprise in cattle breeding for the benefit of any part of India. The chief objects of a Government Cattle Farm should be the improvement of certain work and milk breeds, so that by the distribution of suitable bulls the local breeds in backward districts may be improved. The experience gained at Hissar affords a useful lesson in this and many other directions. At various times good specimens of the finest breeds of India were brought to Hissar. These importations had been reared under very varying conditions of soil, climate, etc., and at Hissar come under the influence of altogether new conditions. These breeds were crossed somewhat indiscriminately in the hope that the good qualities of both parents would be perpetuated in their offspring. Eventually the herd consisted largely of nondescript animals.

The best breeds of India—and India contains several of the very best—are largely the result of their environment, being dependent upon the local conditions or climate, pasturage, fodder from arable land, management and the like. With a transfer to entirely different surroundings, their good qualities may soon disappear. For these reasons, the improvement of cattle of a particular tract is more likely to occur by breeding from the best indigenous stock and distributing bulls so bred, rather than from the importation of even a better breed from a different part of

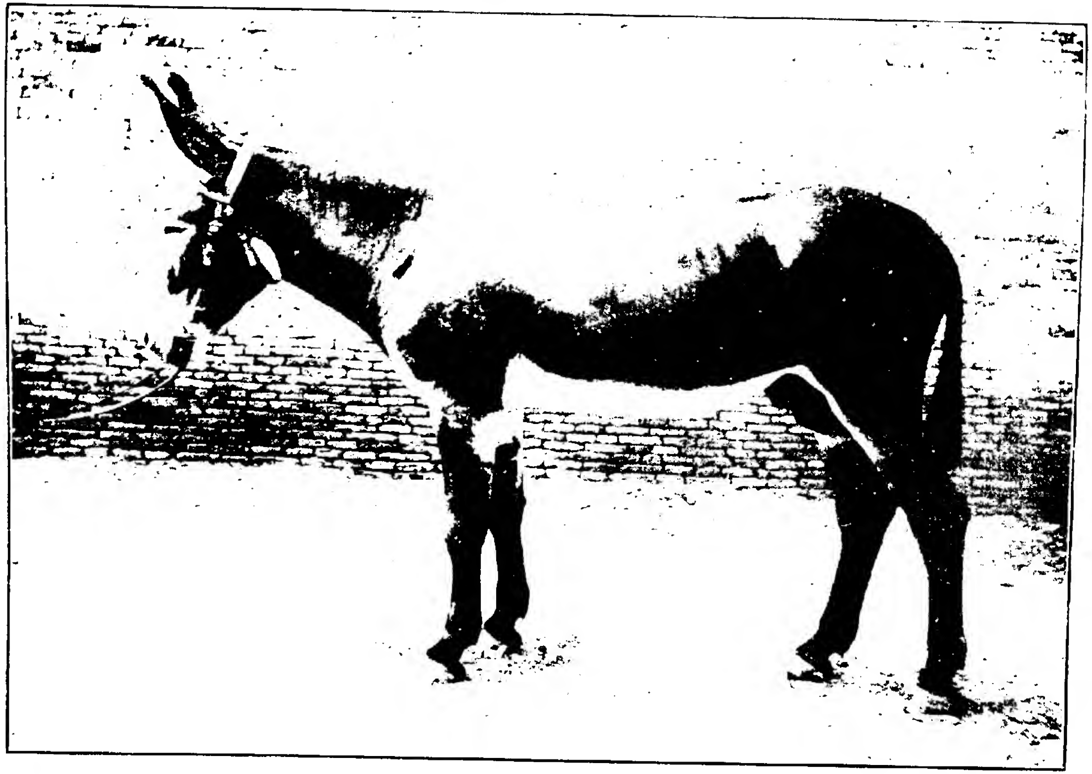
PLATE XXXII



A.J.I.

HANSI JACK.

PLATE XXXIII



A.J.I.

Hissar Jack.

the country, where the local conditions are quite different. I strongly deprecate the advantages of crossing indigenous breeds. Crossing with foreign cattle generally leads to failure. It is probably possible to acclimatize in various parts of India superior breeds of indigenous milch cattle, but for breeding work cattle experience shows that good Indian breeds soon degenerate to the level, and even below it, of an inferior indigenous breed, unless expensive artificial feeding is arranged for.

One important object of a survey of the breeds of Indian cattle should be to determine the conditions under which they are reared and under which they can profitably be transferred for breeding and work purposes from one district to another. These conditions mainly depend upon food supplies and climate. For a Government Farm we should know definitely which is the best indigenous breed of a particular tract. The selection should be made to meet the actual requirements of the tract. It is useless to select as a type, a large, heavy, soft animal, requiring good feeding, if the conditions of the tract demand a small, active, hardy animal that can easily exist on poor feeding. The best type of animal required for local work should be most carefully selected. The object of Provincial Cattle Farms should be to produce really good bulls of correct type specially suitable for the tract referred to.

The Hissar Cattle Farm in the Punjab comprises an area of 44,000 acres, divided into (1) grazing land, (2) flow irrigation land, and (3) lift irrigation land which is leased out to tenants. The cultivated land of 2,500 acres is fenced and is irrigated from the Western Jumna Canal.

The site is thus almost an ideal one for cattle-breeding. There is essentially a large proportion of grazing land, in order to avoid the very great expense of much artificial feeding. This grazing ground gives good pasturage in years of average rainfall and is well supplied with shade trees. The large cultivated area, in years of deficient rainfall, largely supplements the natural grazing and hay by suitable fodder and grain irrigated crops. The Canal also furnishes an ample supply of good drinking-water

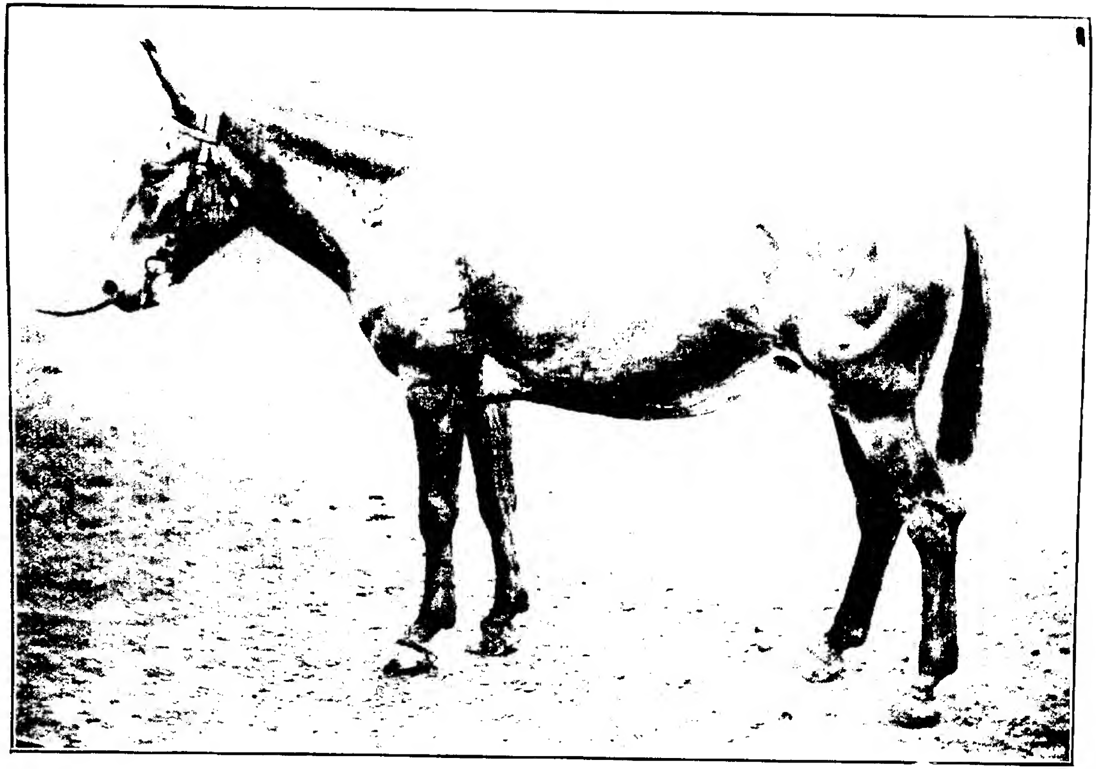
for the cattle. The experience at Hissar has been that overstocking will ruin pasture land, and that a liberal ration, particularly for young stock, is necessary to produce sturdy cattle. Quality rather than size is the chief requirement. Each breeding cow involves the maintenance of three additional animals, for young bulls must be kept for three years before distribution, whilst heifers are not ready for sale till nine months old, and have to be kept for three years before they are bred from.

One bull is generally required in India for about forty or fifty cows. Each herd should be arranged accordingly. A herd of fifty cows can be managed by one herdsman. Each herd should be grazed separately in order to regulate correct breeding. The young male and female stock must be separately herded. They should be weaned when about six months old. The cows will then breed more frequently. The breeding bull of each herd should be changed every third year in order to avoid inbreeding.

The breed of the young female stock should, when three years old, be drafted into the breeding herds to replace the old and worn-out cows. The best of the young bulls should be distributed for use in the districts when $2\frac{1}{2}$ to 3 years old. A rigid system of selection should be followed so that unsuitable young stock may be sold off as early as possible. A register showing the pedigree and other particulars regarding each animal should be maintained. It is not advisable to run a dairy in conjunction with a cattle breeding farm. In handling and milking the cows, they are liable to knock themselves about and slip their calves, whilst the loss of milk to young growing stock is not compensated by the small profits derived from the sale of milk and butter.

It is unnecessary to discuss whether bull breeding or bull rearing farms are best. The correct answer depends on particular local conditions. If promising young calves of pure breed can be purchased, some can be reared into good breeding bulls, although the percentage may be small owing to difficulty in selection among very young animals. In most parts it is impossible to obtain young calves, which are reliably pure bred, and if they are

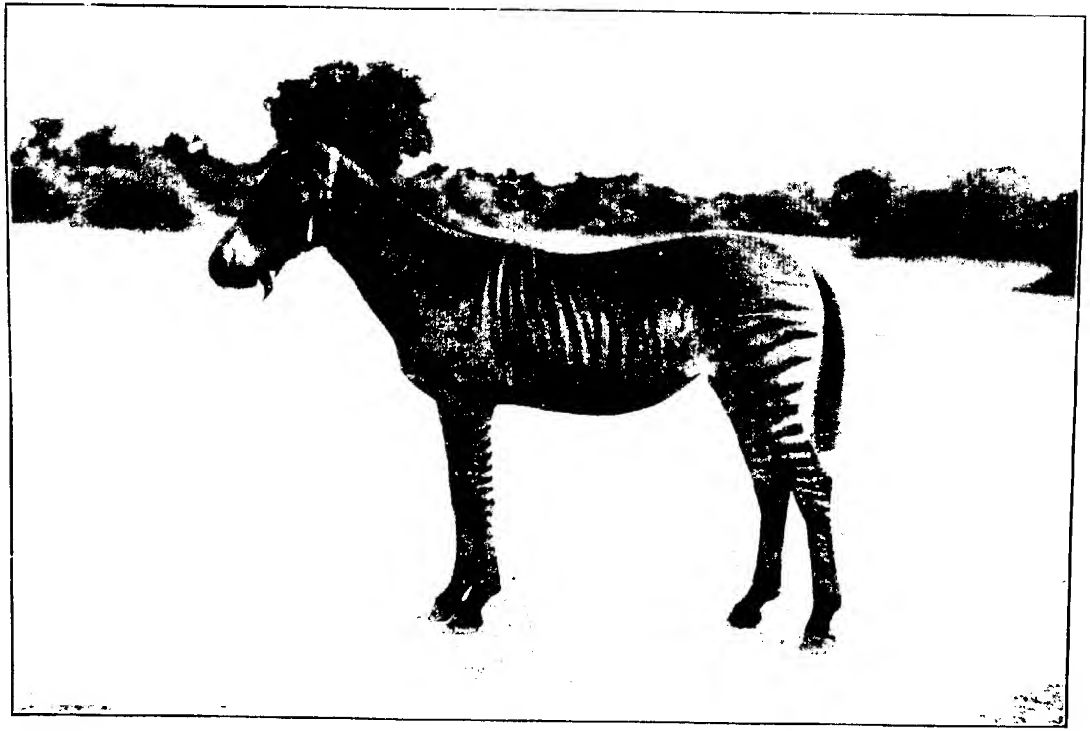
PLATE XXXIV



A.J.I.

HISSAR MULE

PLATE XXXV



A.J.I.

HISSAR ZEBRULE.

available in any number, there is no particular need for a Government Cattle Breeding Farm. In most cases it is preferable to have a bull breeding farm, where all the conditions are under control.

The famous Harriana breed is maintained at the Hissar Farm. This breed is one of the best in India. Good bulls are suitable for most districts in the Punjab and the bullocks are suitable for military and ordinary heavy draft purposes. The main characteristics of this breed are briefly described below :—

Bulls.

The chief measurements of the two best Hissar farm bulls are as follows :—

Herd bull.	Height. Inches.	Girth Inches.	Fore arm. Inches.	Shank. Inches.
No. 1 ...	... 61	84	14¼	8½
No. 2 ...	... 60	83	14	8¼

A true bred Harriana bull is mostly grey in colour but may be black or dark blue over the neck, shoulders and flanks. The skin and hair should be soft and fine. The hump is large in size. The large dewlap hangs in folds. The chest is broad and deep and of good girth. The general frame is well rounded, but is not cumbersome. The tail should be light, short and well set on, the sheath small and close but slightly larger than European cattle. A good bull has a broad, flat back, strong loins, muscular thighs, straight flat leg bones and round, hard black feet. The horns should curve slightly upward and generally dark in colour. The forehead should be broad with the horns well apart. The head should be fairly small, not fleshy and with a clean cut muzzle. The ears are comparatively long. Hissar bulls are gentle in disposition. They are extremely active, quick walkers and the general appearance shows great quality combined with power. A typical specimen is represented in plate No. XXX.

Harriana Cows.

The cows are lighter in colour but a large majority are dark blue over the shoulders, neck and flanks. The head is light ; face

long; horn fine and short. The body is shapely and looks light considering the length of the legs which have flat hard bones below the knees and hocks and hard small feet. The skin and hair are fine. The tail should be thin and fairly short. Many cows milk well and have large udders with teats regularly set. The milk yield from the best cows varies from 6 to 12 seers per day. Both cows and bulls show a well-bred active appearance. See Plate XXXI. The chief measurements of good cows on the Hissar Farm are as under:

Herd Cow.	Height Inches.	Girth. Inches.	Fore arm Inches.	Shank. Inches.
No. 1	54	70	13½	7¼
No. 2	56	72	13¼	8

Donkey breeding.—In consequence of the failure of the supply of good jacks from the European Continent, Cyprus, China, Persia and Arabia, and the great difficulties in importing animals from America, it was decided to start donkey breeding at Hissar. The scheme conclusively proves that with careful selection, judicious breeding and rearing, we can breed donkeys better, more powerful and in every way more suited to our requirements at under one-third of the cost of indifferent ones in foreign markets. See Plates XXXII and XXXIII.

Mule breeding and mule rearing receive considerable attention on the Hissar Farm because of the great difficulty experienced in obtaining ordnance mules in the market. The work has been successful. The young mules bred on the Farm are superior to those obtainable in the open market, and have all been found fit for ordnance purposes (Plate XXXIV). The well-bred Punjab mule has no equal in the world for mountain battery purposes. A certain percentage of these mules are the produce of jacks bred in the Punjab.

Zebrule breeding was started at Hissar in February 1904. Four Zebra stallions (*Equus Burchilli*, variety *granti*) were received, which had been captured wild on the plateau of Central Africa. They soon became perfectly tractable and docile, and a series of most interesting experiments is now being carried on in

PLATE XXXVI

A.J.I.

DUMBA RAM AND DUMBA DECCANI CROSS-BRED SHEEP.

PLATE XXXVII

A.J.I.

DUMBA RAM.

mating them with donkey and pony mares. The value of the Zebra for crossing depends to some extent upon immunity from certain diseases. Plate XXXV.

Sheep. In the Ahmednagar District of the Bombay Presidency I conducted, several years ago, some successful experiments in sheep breeding. The district is an elevated plateau of the Deccan about 2,300 ft. above sea-level. It has a fairly comfortable climate and in normal years a rainfall of 25 inches. The soil varies from deep black cotton soil to shallow red or light coloured soil, the latter largely impregnated with lime.

The experiments were conducted with the object of testing whether the sheep of another country will thrive and adapt themselves to the altered conditions of climate, soil, etc., existing in other parts of India. With this object in view, I obtained Merino ewes from Queensland, Baluchistan, Rajputana and the Deccan and crossed them with Siah Band or Dumba rams, the fat-tailed sheep from the frontier. The average live weight of the various breeds is given below :—

	lbs.
Siah Band or Dumba rams	135
Do. do. ewes	105
Deccan ewes	82
Rajputana ewes	88
Merino ewes	94

Siah Band.—These are the fat-tailed sheep found in Baluchistan and on the Frontier. The wool varies in colour, but the sheep which I selected had white wool of fine quality. The rams and some of the ewes had speckled faces. The rams were hornless. These sheep are square and compact on very short legs. They soon become acclimatised to the heat and other deteriorating influences of the Deccan. The wool, however, got in time somewhat coarse and hairy, particularly on the shoulders. The ewes bred strong healthy lambs with a fair proportion of twins. They had plenty of milk and were good mothers. The lambs fattened rapidly and averaged when eight months old 103 lbs. live weight. Some fat lambs at five months old averaged 93 lbs. live weight. The mutton is delicate in flavour. In their native

country fat-tailed sheep are unaccustomed to any great heat, as their owners always arrange to move them from the plains to the highlands according to the seasons.

Deccan.—These ewes were carefully selected by me in various parts of the Deccan, care being taken that they were thoroughly representative of the breed and with white fleeces. They are hardy sheep, prolific breeders with abundance of milk. The Siah Band cross, on the Deccan ewes, was an undoubted success. The cross bred lambs, averaged when five months old 90 lbs. live weight. These crosses are hardy, come early to maturity and are short legged shapely sheep with much better and heavier fleece than the Deccani. The tail is thick at the root and resembles the Siah Band on a small scale. The average weight of pure bred Deccan fleece is 1 lb. and 3 oz. Average weight of fleece by Siah Band cross is 3 lbs. and 1 oz.

Rajputana.—Fifty selected ewes bought round about Jodhpur and Malwa where the best Rajputana sheep are supposed to be bred were brought to Ahmednagar. They took a long time to adapt themselves to the soil and climate and did not thrive. The cross with Siah Band ram was not successful. The lambs averaged, when five months old, only 40 lbs. live weight.

Merino.—Eleven pure bred merinos were brought from the Hunter River in Queensland. They arrived in emaciated condition, but rapidly put on flesh and produced lambs eight months after arriving in the country. The influence of the Siah Band ram on the offspring was most marked, the lambs taking on nearly all his characteristics. The fleece was completely changed from the compact close curled wool of the merino to a soft silky straight fleece. The lambs were very healthy and strong. The cross produced good mutton sheep.

The whole flock was grazed daily on light upland soil and housed at night when they received a ration of grain chopped guinea grass, lucerne and chaff mixed with some salt.

After several years' experience I came to the conclusion that the Dumba-Deccani cross was the best for the Deccan and

PLATE XXXVIII

A.J.I.

Dumba Hissar Cross-bred Sheep

my flock eventually consisted of only pure Dumbas and Dumba-Deccani crosses.

The annual mortality seldom exceeded 2 per cent. I had no difficulty in disposing of fat lambs of this breed to butchers from Bombay, and some of the ram lambs eventually found their way to New Zealand, and were so much appreciated by breeders in that country that I received several applications for more.

My experiments prove that some indigenous Indian breeds of sheep can easily be improved both in mutton and wool producing qualities, but to obtain such results they must be liberally fed and intelligently crossed. Further, the success of the experiments both at Ahmednagar and Hissar with fat-tailed rams, leads me to think that they should always be used as a first cross in all future experiments in any part of India, as rams of this breed are hardy sheep, capable of standing extremes of climate and undoubtedly increase the weight of the fleece and greatly improve the mutton in weight and quality.

The success of the experiments at Ahmednagar suggested the advisability of starting similar experiments at Hissar where the flock is kept within a maximum of 300. It is almost certain that well selected ewes of any district where sheep are commonly bred can be advantageously kept on established Government Cattle Farms in the vicinity and crossed advantageously with Siah Band rams, one object being to distribute the best young rams in the vicinity. We might in this way do a great deal to improve the flocks in the neighbourhood of our cattle farms and may, in time as the sheep increased in size and value, teach the Indian shepherd to bestow more care and attention on his flocks.

THE TSE-TSE FLY IN INDIA.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

THE part played by tse-tse flies (*Glossina* spp.) in the dissemination of sleeping sickness and other diseases in Africa is now so well ascertained that fears have been expressed that should sleeping sickness be introduced into India, these flies might act as transmitters of the disease and India might be exposed to the ravages of a disease of equal virulence with plague. Cases of sleeping sickness have been reported in India and there is little reason to doubt that coolies returning from Uganda may have the organism in their blood: given these *Glossina* flies biting such infected coolies and then other persons, we have the beginning of an outbreak of sleeping sickness whose limits could not be foreseen.

In view of this possibility, efforts have been made to ascertain definitely if *Glossina* occurs in India. These flies are at present known from distinct tracts in tropical Africa only and they are well defined from other flies and easily recognised. Up to the present no fly of this kind has been found in India: when the enquiry commenced, very little was known about any biting flies except mosquitoes; at present a considerable number of other biting flies have been found, including several "Sand-flies," the many forest flies, and several flies of the house-fly type (*Stomoxys, Hæmatobia, Lyperosia*). These are in some cases very small and very difficult to study, but a good measure of progress has been made.* The fact that throughout this enquiry and in spite of the special efforts made

* For an account of this, see Bulletin No. 7 of the Department, published by the Government Central Press, Calcutta

to find *Glossina*, no fly of this kind has been found, is very strong evidence that *Glossina* does not occur in India. It is practically impossible that so large and distinct a fly, which lives by sucking the blood of cattle, etc., should have escaped notice, when so many inconspicuous species have been found ; it has not been possible to investigate every tract in India, but parts of Assam, Behar, Bengal, Gujrat and the west coast have been investigated specially.

There is the possibility that *Glossina* will be found, say in the North-West Frontier Province, or in Baluchistan, but its significance even then will be much less than if it occurred in India as a whole, and we have no reason as yet to fear that it occurs even in such tracts.

Apart from its occurrence in India, the possibility has been suggested that the fly might be *introduced*, and a question was recently asked in the House of Commons as to the precautions taken to prevent this. Expert opinion in India supports the idea that the possibility of the introduction of the fly is very remote ; the insect is a peculiar one, in that the adult fly does not arise from a maggot, which itself hatches from an egg laid by the fly, but the parent fly deposits a *full grown maggot*, which immediately hides in a suitable place and becomes a hard seed-like pupa from which comes the fly ; that is, the usual cycle of egg, maggot, pupa, fly is not found and the only two stages are the inactive pupa and the fly. Were the volume of trade from Africa to India very large and were it to consist of fodder, or soil or farm yard manure or any such substances in which the pupa would be carried, then we might fear the importation of the pupa from which the fly might hatch.

This is, however, not a likely occurrence, and if the nature of the imports were at any time found to be such as would bring in the pupa, precautions would be possible.

In regard to the fly, no means whereby it could be introduced can be seen : its distribution in Africa is extremely limited, and it will not leave its usual haunts except for short distances : the possibility of its being carried to India is so remote as to be at present *negligeable*.

Even were *Glossina* to be introduced, say to Bombay, the chances against its successful establishment are enormous; one fly cannot carry on the race; even if it be a female, it produces only one pupa at a time and it cannot produce a whole brood at one time, which would be in one place and able to mate and establish a colony. It would be necessary to introduce a large number of flies, to keep them in one place where they could find each other and to provide abundant food, to establish a colony, which not improbably would succumb to the altered climatic conditions of India.

There remains the question of whether any biting fly in India is capable of transmitting the organism causing sleeping sickness and so of playing the part that *Glossina* does in Africa. This can be ascertained only by investigation, and the study of biting flies is the first step towards this.

A systematic study of biting flies has been and is being made, and we may hope soon to be in a position to know all the flies of importance and be able to rear them artificially and provide the material for further study. At present it is not known that any Indian fly will be capable of assuming the function of *Glossina*: there is every reason to believe that *Glossina* itself is absent from India, and we have no ground for fearing its introduction: it is also satisfactory to know that the matter is being very closely watched and studied, and that every precaution that can be devised will be adopted to prevent the introduction and spread in India of the tse-tse fly.

A CONTRAST BETWEEN THE AGRICULTURE OF EGYPT AND OF SIND.

BY G. S. HENDERSON, N.D.A., N.D.D.,

Second Deputy Director of Agriculture, Bombay.

THE lands in Sind are surprisingly like those in Northern Egypt which border the Northern Salt Lakes. Both tracts have a small annual rainfall, are deltaic in origin and each for cultivation gets irrigation from a large river. The soil in each case is alluvial and naturally fertile where here and there it is not impregnated with alkaline salts. In both countries these harmful alkaline salts may not be discovered until irrigation is applied and cultivation started. There owing to high air temperature, particularly at some seasons, excessive evaporation from the soil takes place. There is an upward flow of water to the surface carrying alkaline salts in solution and these are deposited at or near the surface as the water evaporates. In places excessive amounts of alkaline salts thus deposited cause absolute barrenness.

In Egypt practical measures have been taken to remedy such defects which I will describe later in this article. Meantime, the general agricultural conditions in each country may be contrasted.

I will describe the agricultural system of Egypt in a very general way. Upper Egypt is the country of "Basin" cultivation where large or very large "bunded" areas are filled with Nile water when the river is in flood in August. The bunded areas are emptied in October when the inundation has receded. Meantime, much silt is deposited on the submerged lands which

when they are dry enough on the surface are cultivated. They retain sufficient moisture for *Rabi* crops.

Mid-Egypt is a country of exceedingly intensive agriculture. Crop succeeds crop in rapid succession No land is wasted. Crops are systematically rotated. Cotton is the most profitable crop. It gives a very large outturn when carefully cultivated.

In Lower Egypt and especially in that part of it in the North along the sea coast the land differs in quality. There are long stretches of yellowish desert-looking country growing stunted babul and scrub bushes of sorts. It is here that most of the large land companies are engaged. Their enterprise is encouraged by the high prices obtained for land in more favoured parts. With irrigation this land can be improved so as to become valuable.

Egypt has a fine agricultural population. There are over 1,000 people to each cultivated square mile. Waste lands are of course of considerable value to cultivators for grazing as in Sind. The land actually under cultivation or which can be brought under cultivation by irrigation has in recent years largely increased in value and this is due almost entirely to the profits obtained from cotton cultivation. The acre outturn of cotton is in Egypt calculated by Kantars. The Kantar is equivalent to 315 lbs. of seed cotton (seed and lint). The best land which can produce ten Kantars per acre is worth £150 per acre. Very ordinary land produces 3 to 4 Kantars per acre. Prices for Egyptian Cotton are not likely to decrease as the demand much exceeds the supply at present and land capable of growing cotton in Egypt is expected to keep at a high value. Moreover, the area of waste land in Egypt that can be brought under cultivation is small until irrigation facilities are improved. These are contemplated. With land so valuable as it is in Egypt the ordinary cultivator must necessarily be a hard worker. The ordinary tiller understands the principles of rotation and puts them in practice. Wherever cotton is grown in Egypt it is rotated and the general principle underlying the rotation is to have the ground well

covered during the preceding *Rabi* season with Egyptian clover or Berseem (*Trifolium Alexandrium*). This crop is sown in Autumn and gives several cuttings of excellent forage. It is ploughed in during March before the cotton is sown. It manures the soil, improves its physical condition and is otherwise an exceptionally good rotation crop with cotton and cereals. A common rotation on fair land is

1st Rabi.	1st Kharif.	2nd Rabi.	2nd Kharif.
Berseem, sown in September, ploughed in March	Cotton.	Berseem broadcasted in cotton.	Cereal crops such as Maize, Jowar, etc.

The land is always occupied by a crop and the hardening and cracking of surface soil so often found in Sind cultivation is thus prevented. Such ordinary manures as are available are given to the cotton. More elaborate systems of rotation are occasionally practised, but they are not commonly adopted. Wheat, barley, rice, maize, berseem and lentils may enter into a rotation with cotton but the latter is always the chief crop, and from start to finish the utmost care is taken in its cultivation. The land is got into fine tilth and thrown into ridges and the seed is carefully dibbled in by hand. The irrigation is regulated with care. The irrigation beds are small so as to control the inflow of water. The thinning, weeding, and spacing of plants are carefully attended to. In fact, splendid efforts are made to obtain the utmost economical yield from the land.

In contrast, I have to compare the Sindhi "Hari." He is not an assiduous worker and does not make the most of his opportunities. These are great. The Indus flows through the middle of his country and, unlike the Nile, gives water in the middle of summer just when it is most required. Sind has an advantage over Egypt as regards natural drainage facilities. In Sind a certain amount of lift irrigation is required and is perhaps difficult considering the paucity of population. It is

probable that the Sind soils and climate assisted by irrigation are suitable for many of the crops which are so profitably grown in Egypt, but there are difficulties as regards labour at busy seasons. There is much land now lying waste which could be profitably brought under cultivation if we had a larger agricultural population.

Agricultural System in Sind.

The greater part of Sind is irrigated by old inundation canals which are filled on the rise of the Indus in May. The state of the flood regulates the time during which they remain filled as the majority of the canals take off from the Indus at right angles. A large area of land is irrigated by lift. The crops commonly grown under this irrigation are bajri, jowari, cotton and sessamum. The land is bare often for three or four years after a single crop, because the Haris have usually more land than they can deal with. Their cultivation is in fact limited to their ability to lift water. Culturable land which is allowed to be waste soon gets covered with jungle. When brought again under cultivation the jungle is cut down and the soil is softened by flooding. It is then ploughed and sown. The only work afterwards until harvest is to apply water. The Persian wheel or "Hurla" is generally used. One Hurla irrigates 8 to 10 acres according to the depth to water. It is generally worked day and night. The land thus irrigated is well above canal water and there is little trouble with alkali or "Kalar." The method of weeding cotton is characteristic of the slothful methods of the Sindhi "Hari." Volunteers come from the nearest villages and pull up the weeds when about 18 inches high and sell or use them as fodder. At the tails of the inundation canals and in low places which they command, rice is cultivated. This crop is most successfully grown from transplanted seedlings. Gram, etc., are taken as a second crop, but usually the cultivation is extremely careless. In lower Sind at the tails of the Nara, Fulleli and all along the South, the country in flood time is practically a lake, the irrigation water not being under control. Rice is

broadcasted in the water and the cultivation is very primitive and backward.

In the better lands when the floods go down wheat and Jambho (*Brassica Campestris Var*) are grown: also such pulses as mung, guvar, etc.

Cultivation on Perennial Canals.

The conditions are different from those on the inundation canals. The main example is the new Jamrao Canal which has an excellent supply of water all the year round. It is fed from the Indus at Sukkur and of the 250,000 acres which it annually irrigates, 32 per cent is by lift. The cultivation is not on the whole of a high standard. The land is mostly let by the Zamindars to tenants on the share system. During the early years of irrigation good crops of cotton, wheat, bajri, etc., were obtained by means of very heavy irrigation. Exhaustion followed and lands were allowed to be waste for periods of four or five years.

It was in this tract that the Agricultural Department introduced Egyptian Cotton. It occupied 5,250 acres last year. There is no doubt that the crop was sown largely on deteriorated land and the general outturn was poor although in particular cases good yields were obtained. In many instances very little care was given to the crop. The result was weak stunted plants which fell an easy prey to bollworm and other insect pests. On the other hand, on good land with fairly liberal cultivation the crop was over-irrigated and the plants developed vigour of foliage at the expense of flower and bolls. A sufficient number of examples was obtained both in the districts and on the Government Farm at Mirpurkhas to prove that on land in good condition with a fair amount of trouble Egyptian Cotton will give very remunerative results. The crop is not likely to be successfully grown over large areas in Sind until the traditions of the people are changed and the methods of cultivation very much improved.

There are in Sind thirty million acres which with irrigation would be available for cultivation. In 1905-06 the areas under different crops were approximately as under :—

	Acres.
Jowari	700,000
Bajri	900,000
Cotton	300,000
Rice	1,000,000
Wheat	600,000
Pulses	100,000
Oil Seeds	200,000

Reclamation of Alkali and Virgin Land in Egypt.

On land resembling that of Sind in physical and chemical characters the methods of land reclamation in Egypt are very shortly described below :—

In a new tract a complete system of irrigation and drainage is first laid out, the latter being considered of great importance as subsoil water is usually close to the surface. The land is divided in plots of two acres. Each is the unit of the system. Each plot is bunded round with the soil from the drains and is carefully levelled by means of a plough and scraper. If the work is done thoroughly, irrigation and drainage can be kept absolutely under control. Villages are built for each 500 acres forming the "Hod." A European Manager has charge of 6 or 8 "Hods." The parts of the lands above flow level are irrigated by means of a kind of lift which is a modification of the Archimedean screw. It is worked by one bullock or mule, and with a lift of 5 or 6 feet will irrigate 15 acres per day. When conditions are suitable, rice is usually grown for two years after reclamation and the land is considered properly reclaimed when it will grow a crop of Egyptian clover or berseem. In Egypt it is considered that the native cultivator is quite unfit to deal with the reclamation of either virgin or alkaline land, but when reclamation reaches a certain stage, he can be safely trusted not to allow land to deteriorate. At this stage, the land is either let to tenants or sold in small areas, the cultivator being bound down by strict rules as regards crops and clearances. The purchase price is

spread over ten years and is based on the average cotton crop. Sind seems to offer a promising field for similar work, and it is difficult to see how the standard of cultivation can be raised by any other means. It is certainly worth a trial on a small scale by Government in view of the proposed large extension of perennial canals in the near future. As a commercial undertaking, provided suitable terms are obtained from Government, it offers sound prospects to any concern having the necessary capital and technical skill. The labour problem presents some difficulties, but according to the report of the recent deputation to the Punjab, plenty of labour can be had on condition that the coolies get land to cultivate.

NOTES.

A Pest of Indigo in Behar.—Reports received from the Behar Planters' Association, show that the Indigo crop of Champaran has this season suffered from an unusual pest. The terminal shoots of the plant, instead of growing normally, become twisted into a compact knot of leaves which prevents further growth. Planters state that plant growth is so checked that the yield of indigo is reduced sometimes by 50 per cent. or more and on considerable areas the crop has died outright. Investigation has shown that the curling of the leaf and shoot, with the cessation of growth, is due to the presence of a small insect, described in 1890 as *Psylla isitis* from specimens sent from Bengal (see Indian Museum Notes, Vol. II, No. 1). This small flattened insect pierces the leaves and terminal shoot, extracts sap and probably injects a poison, which causes the plant to produce abnormal growth. The result of the attack is the formation of the twisted knot of leaves in which the insect lives, and which gives an attacked field a peculiar appearance and dark colour which is easily recognised.

This pest has not been particularly noticed by planters during recent years but has been observed on the Pusa Farm and elsewhere in Behar during the past two seasons. It was also reported from Madras in 1905. It is not a new pest, but the insects finding large areas of suitable food plant have multiplied and have, therefore, become injurious.

One point of interest in the present enquiry is whether the insect is likely to recur or is sporadic. Possibly the pest was abundant and injurious in 1907 on account of favourable climatic conditions. There were prolonged periods of dry weather at times when rain usually falls and the total rainfall was under average.

The Indigo crop had, therefore, adverse conditions to contend with. The weakened crop, as usual, suffered more from these insects than a healthy crop would have done. Therefore, I consider that in normal seasons the same extent of loss need not recur. It is, however, possible that the altered conditions of indigo culture during the past two years may have influenced this outbreak. Formerly the Sumatrana plant alone was grown and this stood in the ground only from March to October. There was then no food for this pest from November to February, and this was probably the greatest check on its increase. During the past few years, the Java-Natal plant has been extensively grown. This plant is perennial and is left on the same ground for two years or longer. A particularly destructive insect thus finds suitable food all the year round and this probably led to increased numbers of insects and increased damage to crops of Indigo. If this is the case, we may expect considerable damage from this pest again in 1908. The crops should be carefully watched. We cannot at present decide the cause of the present attack.

The Sumatrana plant has, in all cases, suffered much more severely than the Java-Natal, though the latter is not exempt from attack. The dying out of Sumatrana Indigo in several cases was due to different causes of which the insect is only one.

Next year's cultivation will probably determine how far the cultivation of Java-Natal Indigo will help the propagation of the pest. If the losses in the Sumatrana plant are very severe, there will be another reason for abandoning this plant in favour of the Java-Natal which gives more dye per acre and for the time being is apparently more immune against plant diseases and insect attacks than the variety which has been long cultivated in Behar. (H. M. Lefroy.)

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Cattle-Breeding Experiments on the Upper Shillong Experiment Station.—The Annual Report of the Upper Shillong Experiment Station, for the year ending 30th June 1906, shows that the Farm has a herd of cattle for cross-breeding experiments. The herd consists of cross-bred English, Bhutia and Khasi

cattle. The first is commonly known as the Patna breed and was established about the time of the Mutiny by Mr. Taylor, Commissioner of the Patna Division. These cattle may now be looked upon as more or less fixed in type. They are also to a considerable extent immune from Rinderpest and other deadly diseases to which newly imported cattle readily succumb. Therefore, they can safely be used for crossing purposes and perhaps with considerable advantage in improving milking capabilities as the Patna cows are on an average exceptionally good milkers in comparison with any pure Indian breed. These cross-breeding experiments are interesting, and will, it is hoped, be continued till definite results are obtained. (EDITOR.)

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USEFUL RESULTS FROM AN AGRICULTURAL SHOW. An Industrial and Agricultural Exhibition was held in Bombay in 1905. In the agricultural section many ryots took keen interest in the various exhibits. I refer to this show now because it since produced many practical results. Such shows could, with advantage, be held annually in every province.

The show included a dairy with all up-to-date appliances, selected milk cattle, the best specimens of agricultural produce suitable for the country and for export, also agricultural machinery. There were also practical demonstrations in ploughing, water-lifting and such like, all of which may influence the improvement of Indian agriculture to a very considerable extent.

In reference to the interest taken by cultivators in particular sections of the show, the following special arrangements have been made by the Bombay Government :—

(i) On the Bombay Government Farms agricultural implements, which were seen at the exhibition, which are not generally used but which have been proved to be efficient, are kept in stock for purchase by agriculturists at cost price or by means of Takavi advances.

(ii) A small trained staff with boring apparatus will be maintained in each division to demonstrate to ryots where well water can be successfully obtained.

(iii) An officer of the Public Works Department will be placed on special duty to show how irrigation can be got economically from rivers and other sources of perennial supply by means of oil engines and pumps.—(EDITOR.)

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EXPERIMENTS WITH MUSTARD SEED AT THE DUMRAON FARM.—In 1903, it was brought to the notice of the Inspector-General of Agriculture that the mustard and rape crop in Bengal was deteriorating owing to the inferiority of seed sown. Small samples of good varieties were obtained from other provinces and tried on the Dumraon Farm. These trials have been continued for four years and have given interesting results, which have been published in leaflet No. 6 of 1907, recently issued by the Bengal Department of Agriculture. The results show that the local variety is the poorest yielder of the varieties tried. Raipur mustard has given the best yield for four years with an average outturn of 3 maunds per acre above the local variety, while another variety from Jubbulpore in the Central Provinces is a good second with an average increased yield of $2\frac{1}{8}$ maunds per acre. Dr. Leather's analysis further shows that not only is the local variety a poorer yielder than Raipur or Jubbulpore mustard, but both these introduced varieties contain a higher percentage of oil than the local variety.

The crop can be grown in Bengal in the same year after paddy and probably elsewhere in many parts of India as a second crop if sufficient moisture remains in the soil in the Rabi season.—(EDITOR.)

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COTTON GROWING IN QUEENSLAND.—This Colony seems suitable for cotton growing. It is suggested that the best qualities of cotton can be grown on very large areas in this country. The harvesting time of the crops falls well within the dry season, so that picking is not interfered with by rain, which would spoil much of the crop. But labour is scarce and dear, and this may

interfere with commercial success. Mr. Bottomley, an expert regarding cotton cultivation, is, however, somewhat enthusiastic about the success of the cultivation of the crop in Queensland; and he believes that large areas of land now under maize might be occupied by cotton and that a large export trade to Lancashire might result without any probability of cessation. He thinks high class cotton can be grown in Queensland, cheaper than in any country in the world. The estimated cost of production is, however, put at £3 to £4 per acre. In India our cultivation and transport charges to seaports are much less than this. The Australian Government have been advised to establish an Experimental Station and a seed farm and arrange for the distribution of selected seed to cultivators. —(EDITOR.)

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AGRICULTURAL ASSOCIATIONS IN MADRAS. —A Central Agricultural Committee was established in Madras in 1905 and is connected with the Victoria Technical Institute. The Committee holds quarterly meetings. District Associations are represented. Bulletins regarding agricultural enquiries of special interest are published. By way of assistance the Government of Madras have recently sanctioned an annual grant-in-aid to the Committee. There are at the present time 22 District Associations and 46 Branch Associations in the Presidency. Many of these are dealing with the main agricultural defects of their districts and taking steps to remedy them. Several of the District Associations guided by the expert advice of the Agricultural Department have started, or are about to start, experimental farms with various practical objects in view. Apprentices for definite agricultural work are being trained for demonstrating improved methods of agriculture. The most definite lines of enquiry are as regards the introduction of new crops, improved methods of cultivation, better methods of preparing crude sugar, the improvement of fodder supplies, the manufacture of cheap improved agricultural implements and the encouragement of cultivation by irrigation from wells by oil engines and pumps. —(EDITOR.)

SOME AGRICULTURAL INDUSTRIES IN CEYLON.*—In 1906, the agricultural industries in Ceylon continued chiefly prosperous. The trade in tea, cocoanut, cardamom, cocoa and citronella oil remained satisfactory. The value of the trade in citronella oil materially increased and this trade, owing to increased demand, will probably increase in Ceylon and India. A rise in value has stimulated the cultivation of camphor. The distillation of this product has been improved and thereby a larger yield obtained. The cultivation of rubber and tobacco has greatly increased. Improved methods of curing tobacco are receiving attention. Larger irrigation works for paddy are in progress and the general agriculture and horticulture of Ceylon seems to be at present in a very satisfactory condition.—(EDITOR.)

INOCULATION FOR LEGUMES.—Experiments carried out with the nodule bacillus isolated from the roots of pigeon pea (*arhar* or *túr*) show that for this crop no advantage is likely to result from bacterial inoculation in those parts of Northern India where the pulse is cultivated. It was tested both in Dehra Dun and Pusa. In sterilised soil, in which the bacilli naturally present had been destroyed, the method recommended by the U. S. Department of Agriculture gave a copious crop of nodules and correspondingly vigorous plants. Tried in the field, however, this advantage was lost, for both in soil that had not carried this crop for some ten years, and in soil that had borne it the previous year, no benefit resulted from the operation. The Dehra Dun plots were approximately one-tenth acre and the difference between the inoculated and non-inoculated plots was one per cent. in favour of the latter, an amount which is well within the limits of error of a field experiment. It is probable that the soils of Northern India contain a sufficient quantity of the nodule bacilli naturally to supply the needs of the commoner pulses grown.—(E. J. BUTLER.)

* Board of Trade Journal, No. 558, Vol. LVIII, 8th August 1907.

Indigo Wilt Disease in Behar.—Several cases of this disease have been reported in Behar recently. The cause is a fungus, *Neocosmospora vasinfecta*, well known as causing similar diseases of cotton, water melon, cowpea, bhinda (*Hibiscus esculentus*) and other plants in the United States. This fungus can only be distinguished from several other allied soil fungi in its perfect fruiting condition, and the recent discovery of this condition for the first time in India leaves no doubt that the disease has reached this country. Besides indigo, gram and rahar are affected in Behar. The parasite lurks in the soil, being able to remain alive for at least three years in fallow soils. It enters through the young roots and penetrates the base of the stem. As a result of interference with the water supply the plant dries up. Both Java and Sumatrana varieties have been attacked. The only hope of checking diseases of this nature is by the discovery of resistant varieties, and it is therefore clear that an important part of future work on indigo will be the separating into pure races, where this is possible, of all the varieties that can be obtained in India or abroad, and testing their resistance to the disease. Land which has shown this disease should not again grow indigo, rahar or gram for at least three years.—(E. J. Butler.)

* * *

The Destruction of Date Palms by Tapping.—It is well known that great mortality occurs in Indian date palms in some districts as a result of tapping for the production of toddy and palm sugar. This has been referred to in the Report of the Indian Excise Committee recently published (p. 69, paragraph 169). It is stated to be a matter which urgently demands notice, particularly if the development of palm sugar manufacture should be extended. The ruthless destruction of date palms by tappers is said to be most evident in Madras. In Bombay less injury is caused and the least in Bengal. In a letter from the Secretary to the Excise Committee, it is stated that in Bengal the incision is well below the head of the tree, roughly triangular, with its

point upwards, and comparatively shallow, though broad (Fig. I, B.). In Bombay the cut is oval and nearer the head (Fig. I, C.). It is frequently deepened until it passes through the stem. In Madras the incision is right under the head and is triangular as in Bengal, but with the point downwards (Fig. I, A.). It is well to mention, however, that other accounts of the methods of tapping in vogue in different Provinces do not altogether agree with the above. The Jessore district of Bengal for instance appears to employ the system here described for Madras.

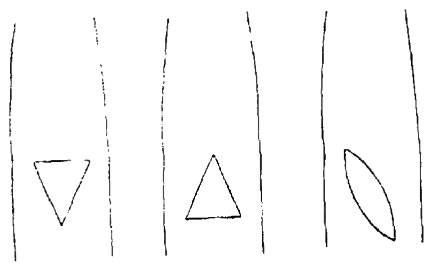

Fig. 1

It is possible that a consideration of the anatomy of the palm stem may afford a clue to the explanation of these results of tapping.

The leaves of palms are bunched together at the crown. On a full grown tree only those lowest on the bunch are active in contributing to the support of the tree. These are the fully expanded green leaves, which are actively engaged in manufacturing starch and other food, and are directly or indirectly the source of the sugary substance in the toddy juice. Above them, and enclosed in the bud by a series of tubular sheaths, are a number of young leaves, the youngest leaf and the growing point being sunk in a little depression at the apex of the stem.

The fully active leaves are supplied with water bearing dissolved salts, from the roots, through vessels grouped in bundles.

These are, in palms, as in all the division of plants to which the palms belong, scattered through the thickness of the stem, not arranged in definite rings towards the surface. Hence it is that palms cannot be killed by "ringing," and that they are enabled to stand the severe wounds inflicted on them by the tappers. It is, however, essential for the well-being of the tree that the main vessels going to the active leaves should be as little interfered with in the operation as possible.

The vascular bundles of palms are peculiar in several respects. In a transverse section of the stem they occur crowded together in large numbers near the surface, and successively diminish in numbers and increase in size towards the centre. In the outer layers the bundles contain no active vessels but are mere fibrous threads. On tracing these up they are found very gradually to sink into the interior of the stem until they approach the leaves, when they curve rapidly out again into the leaf to which they belong. As they become more internal, vessels are found, gradually increasing in size until they reach a maximum at the deepest part of their course. Hence the general statement can be made that the vessels run rapidly from the leaf in a curved path towards the centre of the stem, and from there pass downwards and very gradually outwards towards the fibrous layer near the surface of the stem. As the bundles approach this layer, their vessels disappear, and the layer itself is formed only of fibrous continuations of the bundles. In this course union of one bundle with another is rare, each pursuing an individual course. The middle vessels of each leaf reach the centre of the stem in their inward curve, while the lateral vessels penetrate a shorter distance.. The former also run down approximately in one plane while the latter run in a spiral to right or left and reach the fibrous layer in a position not directly under that in which they enter the stem.

Hence in a longitudinal section of a palm stem the middle vessels of the leaves may be imagined somewhat as in the diagram (Fig. II). The crossing which is shown is due to the fact that the vessels of the youngest or uppermost leaf are

always the most external, and hence vessels running to any one leaf must cross those going to leaves higher up.

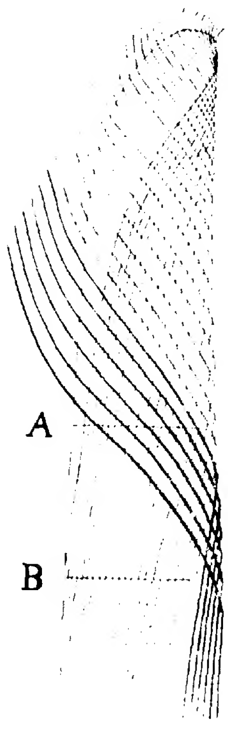

FIG. 11.

It appears to be evident from the diagram that a cut at **A** directly under the crown of leaves, as in the Madras system, will divide a number of the main vessels going to the actively functional leaves, which are those lowest in situation on the crown. It will also divide them in their course from the leaf to the centre of the stem a part in which they are large and active. A cut at **B** on the other hand will divide the vessels going to leaves still enclosed in the bud and, therefore, not yet functional, and will divide them in their lower part as they approach the fibrous layer towards the outside of the stem, where the vessels are small and probably of little importance. The result is that a cut at **A** may cause serious stoppage of the raw food and water supply to the manufacturing leaves, and this will be the more serious the deeper the cut and the larger the portion of circumference it involves.

On the other hand, since the flow of toddy comes from the divided vessels, it seems probable that the maximum outflow will be produced by a cut at **A**.

The truth of these suppositions can only be tested by experiment. It is, as a matter of fact, extremely difficult to trace out the course of any large proportion of the vascular bundles, and to decide exactly what injury will be caused by a cut at a particular spot. They cross and intertwine in a most confusing manner, owing chiefly to the oblique course of a large proportion of them. Lateral connections between the different bundles would be of importance in providing an alternative path for the

sap in a divided vessel, but they are stated, and appear, to be rare. Still it seems likely that there must exist some such path by which part of the water current can be deflected around large wounds. It is difficult otherwise to explain what advantage can result from the practice of tapping alternately different sides of the tree, which is nevertheless almost universal.

Without entering into these anatomical questions, it is certain that much useful information could be derived from systematic experiments.

In the first place, it appears necessary to test by direct experiment the effects on the active leaves of wounds of different depths and areas, inflicted directly under the crown and also at a little distance further down. The shape of the wound should also be varied, the triangular cuts of Madras and Bengal with the deepest portion above and below respectively, and the oval cut of Bombay being compared. Other incision such as spiral or V-shaped might also be tried. In the next place, the amount of juice obtained with different types of incision requires investigation. Finally, it would be necessary to see how far the two requirements avoidance of serious injury and extraction of the maximum amount of juice, can be reconciled. It is clear also that the methods of tapping actually in use require much more careful examination than they have received. Much time would be saved by working from the known to the unknown, and it is scarcely possible to plan a detailed series of experiments in tapping until local practices have been fully investigated.—(E. J. BUTLER.)

* * *

BOMBAY COTTON SEED CAKE.—Dr. Voelcker, in his Annual Report to the Royal Agricultural Society of England for 1906, draws attention to the fact that the amount of sand in Bombay cotton cake has increased somewhat of late, or in other words, the seed used is rather more dirty.—(J. WALTER LEATHER.)

* * *

SORGHUM POISONING.—In view of the number of cases of sorghum poisoning which occur in India, the following note,

taken from the July Number of the Queensland Agricultural Journal, may be of interest :-

"A very important discovery with regard to sorghum poisoning was made by Dr. S. Avery, Chemist of the Nebraska Agricultural Experiment Station, who has shown that Carbohydrates (sugars, as glucose, milk sugar and molasses) act as an antidote against the poisonous action of prussic acid and the prussic acid yielding glucoside. The presence of sugars in the first place retards the action of the enzyme in liberating free prussic acid; and again, prussic acid unites with sugars to form less poisonous addition products. Dr. Avery recommends, therefore, to give to an animal suffering from sorghum poisoning, in a case that its condition still allows medical treatment, a strong solution of glucose syrup or molasses; or, again, a large quantity of milk. Actual experiments have shown that an animal could be given a large dose of pure prussic acid, up to three times the fatal dose, if glucose was given at the same time: the animal became very sick, but still recovered. Farmers have, therefore, a fairly safe remedy in molasses for these cases of poisoning. Treacle is a cheap and valuable cattle food in almost any country, especially for sweetening bhusa, chaff and such like fodders."—(A. G. Birt.)

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South African Locust Fungus.—As mentioned in a former issue (*Agricultural Journal of India*, Vol. II, Part 2, p. 208, April 1907), experiments with the fungus received under this name from South Africa have failed to show that it is capable of killing Indian locusts and grasshoppers. A recent publication of the Transvaal Department of Agriculture (Leaflet No. 5, Division of Botany, 1907), helps to explain this failure. It is shown that the true natural locust parasite in South Africa is a different fungus ("*Empusa Grylli*") to that which has been distributed under this name ("*Mucor exitiosus*"). The former, while a deadly enemy of locusts, has not so far been cultivated artificially and hence is not available for systematic use against these pests. The latter is probably quite harmless to locusts and

most likely only grows on their dead bodies after they have been killed by the former or have died from natural causes. As the latter is the one which has been widely distributed for testing in India and elsewhere, it is not surprising that no good results were obtained. It would be interesting to know whether the true locust parasite "*Empusa Grylli*" occurs in India, as up to date it has not been found. Any one who observes locusts or grasshoppers dying in numbers from no evident cause, would confer a favour by immediately sending specimens of the dead locusts to Pusa for examination. Unless, however, some means can be found of cultivating the fungus artificially, it will not be practicable to attempt to disseminate it on a large scale.—(E. J. BUTLER.)

THE STRENGTH OF WHEAT FLOUR. In the *Journal of Agricultural Science*, Vol. II, Part 2, of 1907, Mr. T. B. Wood details the results of an experimental investigation on the cause of the strength of wheat flours. To what this strength is due is a matter of much discussion. Chemical examination of flours has so far led to very little increase of our knowledge of the subject. Since Biffen has shown that "strength" is a Mendelian character, that is to say "hereditary," the question of obtaining strong wheats seems to rest in the hands of the plant breeder.

The size of the loaf of course depends on the strength of the flour from which it is made. Mr. Wood shows that the factor which primarily determines the size of the loaf which a flour can make is quite distinct. Flour contains a certain amount of sugar, but it is also capable of forming more sugar from the starch which it contains by reason of its "diastatic power." This "diastatic power" is due to the presence of the ferment diastase which can convert starch to sugar. The paper in question shows that the size of the loaf depends in the first instance on the amount of sugar contained in the flour together with that formed in the dough by "diastatic action." Mr. Wood proposes to measure these amounts by incubating flour with yeast and water, and collecting and measuring the carbon dioxide gas

evolved during 24 hours. It is the amount of gas evolved in the latter stages of fermentation which more directly determines the size of the loaf. It is probable that the shape of the loaf depends on the physical properties of the gluten.—(H. E. ANNETT.)

LOSSES IN MAKING AND STORING FARM YARD MANURE.—In the *Journal of Agricultural Science*, Vol. II. Part 2, Mr. T. B. Wood discusses the causes which give cake-made dung a high reputation among practical men. The author's experiments seem to establish this reputation from a chemical point of view, and they offer us the probable explanation. He shows that there is much more ammoniacal nitrogen in dung from cake-fed animals than from animals fed on a poor diet. This form of nitrogen is readily available for plant food and produces a vigorous effect on the crops to which it is applied. At the same time cake-made dung is found to be more readily fermentable than dung made from poorer foods. Consequently it is more liable to loss during storage, and this loss falls chiefly on the readily fermentable ammoniacal nitrogen.

The author concludes that in ordinary good farming one-half the nitrogen of purchased foods is recovered in the dung.—(H. E. ANNETT.)

PRODUCTION OF TEA IN INDIA.—The annual statistics of the production of Tea in India have recently been published by the Commercial Intelligence Department from which the following main features are taken.

The total area, 531,808 acres, is only slightly greater than that of the preceding year, but the increase since 1885 has been 85%. The total production now stands at 240 million pounds, of which nearly the whole is exported; the United Kingdom is the chief customer and takes 73%. The increase in production since 1885 is 236%. The quantity of green tea made is only nominal and does not appear to be increasing. The quantity of tea consumed in India is estimated at 7 million pounds. The prices

of the last year were appreciably better than in 1905 for all qualities and in all districts. The capital invested amounts to about 21·8 crores of rupees, and the number of persons employed is close on half a million.—(J. WALTER LEATHER.)

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INDIAN DYES.—In a recent Memoir* of the Asiatic Society of Bengal, Mr. E. R. Watson details the results of some interesting experiments which he has made on the fastness or permanence of indigenous dyes of Bengal when exposed to the influence of light, soap, alkali and acid and which he has compared with pure artificial dyes. He finds that some, such as "bakalu" (ex *Cæsalpinia sappan*), "manjista" (ex *Rubia cordifolia*) and "catechu" (ex *Acacia catechu*), whilst not ranking so high as turkey red, compare very favourably with the great majority of synthetic products. Latkan (ex *Bixa orellana*), red sandal (ex *Pterocarpus santalinus*) and padauk (ex *Pterocarpus dalbergioides*) fade so readily on exposure to light that their value is only nominal, whilst some dyes such as "turmeric" (ex *Curcuma longa*), "kusum" (ex *Carthamus tinctorius*) and "palas" (ex *Butea frondosa*) are extremely readily affected by all agencies.—(J. WALTER LEATHER.)

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LEAF MANURE.—*Apropos* of the value of leaves as a manure, the February issue of the Queensland *Agricultural Journal* states that it has been proved by Grandeon and Henry, two of the Nancy Professors, that besides serving as food for earthworms and other organisms, the activity of which keeps the soil porous, friable and superficially rich in nutritive mineral matter, dead leaves fix atmospheric nitrogen to the extent of 12 to 20 lbs. per acre annually.—(T. F. MAIN.)

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COTTON IN WEST AFRICA.—The British Cotton Growing Association have issued their Second Annual Report describing the experimental work which they have carried out on the West

* Vol. II, No. 3, price Re. 1.

Coast of Africa. It appears that the Association have seven plantations in the three districts of Western Africa, *viz.*, Southern Nigeria, The Gold Coast and Lagos. The Report does not take a very optimistic view of the prospects of cotton in those parts, especially in Southern Nigeria where a species of insect, one of the bollworm class, has wrought havoc among all varieties, native as well as exotic. The cotton seems to have suffered considerably from a number of insects and fungoid diseases of which the "bollworm" and "blight" have done the most damage.

Judging from the few results obtained up to date, none of the varieties of Egyptian cotton are likely to prove successful, trials have been made with Yemovitch, Abassi and Metafiffi with very disappointing results. A few of the native varieties have given moderate outturns, but some of the Americans have given much the best results.

The proportion of lint to seed appears to be fairly satisfactory in most cases and prices equivalent to those current for Middling Americans have been obtained.

While the report on the whole takes a somewhat gloomy view of the future of the cotton industry on the West Coast of Africa, it must not be forgotten that the experimental work is still in its initial stages, and the results obtained up to date cannot be regarded as altogether final.—(T. F. MAIN.)

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MADURA CATTLE SHOW, 1907.—This Show is held in connection with an old established annual fair to which large numbers of cattle are brought. In May 1907, about 16,000 cattle were brought for sale. Selections were made from these and only the best animals were admitted into the Show enclosures. These consisted of

68 pairs of bullocks,
12 breeding bulls,
4 cows,
92 Jellicut bulls.

The Show was organised by the Madura District Agricultural and Industrial Association, assisted by the Agricultural, Revenue

and Police Departments. It was not very successful this year and it is clear from the report that the exhibitors were somewhat suspicious as regards the objects of the Show. The Committee are bent upon popularizing it, and prejudices will disappear in time. At these large annual fairs, which are common in many parts of India, there are great opportunities for demonstrating agricultural facts which may prove of great value to practical agriculturists. It would, for instance, be easy to show by lantern slides the life histories of particular harmful insects, and it would not be difficult to describe the actual damage done and give an estimate of actual loss and the means of combating it. The Agricultural Department could moreover have an exhibit stall for specimens of crops, implements and such like, which had been proved to be specially valuable in particular districts, with an educated attendant in charge fully qualified to explain all circumstances to the people in their own language. The value of demonstrations of this kind cannot be questioned

In some parts of India it is, I know, very hard to overcome the prejudices of agriculturists. In time, antiquated traditions will disappear among agriculturists everywhere. The Association will doubtless aim to extend the scope of the Show to include exhibits of all kinds of agricultural produce sheep, goats, buffaloes and particularly young stock.

In the Canal Colonies of the Punjab the new Colonists show great emulation in exhibiting, at an annual fair, the produce of their farms, their cattle, horses, etc. The Lyallpur Fair, for instance, is really a "week" which combines, in a very practical way, business with pleasure. The Colonists, encouraged by the Colonization Officer, are uncommonly keen on sports, but they are also uncommonly keen to sell the produce of their lands and surplus stock to the very best advantage, and both objects are attained. I suggest that the Lyallpur fair provides an object lesson for other parts of India.

It is suggestive that 92 of the entries at the Madura Show were bulls which are reared specially for "Jellicuts or Thamashas." *A game is played with them which may be described as bull*

bartering. The more spirited and fierce the bull is the more he is valued. I believe that if the Executive Committee took a special interest in these and other pastimes and encouraged them, it would be easy to develop the Madura Show into a sound annual agricultural exhibition. If the Sahib gets in touch with the people over their sports and pastimes, he will easily influence them in other ways.—(EDITOR.)

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THE CULTIVATION OF MANGEL WURZEL.—(Agricultural Department, Bengal, Leaflet No. 11 of 1907).—Good results have been obtained in several parts of Bengal, with this crop, when grown in the Rabi season with irrigation. A rich loam or clayey loam soil is required, also good cultivation and liberal manuring. A heavy dressing of cow-dung and two to four maunds of common salt are recommended. Two to five seers of seed should be sown per acre at any time from November to February, in rows two feet apart. The plants should be singled out a foot apart when they are fairly established. The crop is harvested when the leaves turn yellow, the roots being pulled by hand. They can be stored in a heap under cover and when fed to cattle should be sliced with a chopper. The leaflet makes no mention of the great obstacle to the cultivation of this crop, its liability to destruction by insects, which attack it seriously in this country. The crop, at Pusa last season, weighed less than 20 tons per acre or about half a really good crop in England.—(EDITOR.)

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CONSERVATION OF MANURE.—(Agricultural Department, Bengal, Leaflet No. 7 of 1907).—This leaflet describes how the dung and urine of cattle should be conserved. It is pointed out that the phosphoric acid is in the dung and the available nitrogen and potash in the urine, and as these are the most valuable constituents in manure, they should not be lost. Cattle stalls should, therefore, be so made that the urine runs off into a receptacle from which it is added to the manure heap or pit or at once applied to the land. A pit is recommended for the storage of manure both liquid and solid. In districts of heavy rainfall the pit should be

roofed, and to prevent excessive heating, manure should be packed down tight in the pit as occasion requires. If a manure heap must be made in the open, it should be mixed with earth and covered to a thickness of six inches with loamy soil.—(EDITOR.)

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ENSILAGE FOR FODDER.—(Agricultural Department, Bengal, Leaflet No. 8 of 1907).—A statement of the processes occurring in the making of ensilage and the temperatures, etc., required to make the best quality. Directions are given for the preparation of simple silos in two forms, the stack silo, the pit silo. The use of a thermometer in determining temperatures is recommended and careful directions are given to prevent damage from water. Maize, cut when nearing maturity, and juwar, cut when the grain is formed but not ripe, are recommended for ensilage and the danger of poisoning from young juwar is pointed out.

The leaflet contains valuable information scarcely suited to any but a very advanced farmer, who could understand the use of the thermometer and the term 110° F.—(EDITOR.)

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BONEMEAL AND SALTPETRE AS A MANURE FOR PADDY. (Agricultural Department, Bengal, Leaflet No. 10 of 1907).—Selected raiyats of the Burdwan Raj were supplied with bonemeal and saltpetre for application to paddy: the results obtained show that, where the manure was used, the average outturn per bigha was 13·4 maunds of grain and 18·2 maunds of straw, against 6·5 of grain and 9·9 maunds of straw from unmanured land. The cost of the manures was Rs. 4 per bigha (1 maund of bonemeal, 10 seers of saltpetre), while the increased return is Rs. 25, showing a clear net increased yield of over Rs. 20 per bigha. There is no doubt that experiments have proved that bonemeal has a special value on the paddy fields of Bengal in comparison with arable areas in other Provinces. (EDITOR.)

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RUST IN THE PUNJAB, 1906-07. The cold weather was longer than usual with much rain and a very large number of cloudy

days in the last fortnight of February and in March. The consequence was that the crop was late by quite a fortnight by the end of March and there was a considerable amount of rust. The weather changed on the last day of March suddenly becoming very hot for ten days. The result was that the crop ripened unnaturally fast and produced weak and shrivelled grain. This view is, I think, fairly well confirmed by the fact that the late wheat suffered most and in many cases the ears were quite barren.

As regards the part played by rust, I think it would be a very difficult thing to separate out its specific share of the damage. Where it came in was, I think, in *weakening* the plant and making it less fit to cope with the sudden change of weather. The same occurrence took place some ten years ago, but I cannot give definite particulars. All I know is from hearsay. I consider that the crop here under similar weather conditions would be very liable to again suffer in the same way. It is fairly certain that rust was not the *sole* factor in the loss but I am quite sure that it played an important part in it. In the Colonies the total shortage is probably from ten to fifteen per cent. on the first sown crop and from twenty to thirty per cent. or even more on the later sown crop.

I think that if the weather had warmed up gradually we would probably have had a normal crop. My opinion is that an ordinary healthy crop protects itself from the effects of the sun's heat by evaporation, but that a rusted crop has not the same evaporative power and consequently suffers badly. I think a healthy crop might have resisted a sudden change of temperature. If so, the whole damage was caused by rust. We have unfortunately not enough data to do anything else but guess, but I think the two factors were undoubtedly *weather* and *rust*, and their separate effects cannot, I am afraid, be isolated.—(S. MILLIGAN.)

LITERATURE.

Manual of Irrigation Wells. By E. A. Molony, I.C.S., *Collector of Gorakhpur.* (Bulletin No. 22 of the Department of Land Records and Agriculture, United Provinces. Price, 12 annas.)

In this manual Mr. Molony goes into great detail when discussing the principles which underlie the science of well-boring. Having first described these in popular language, the author proceeds to treat the subject in a thoroughly scientific manner, devoting separate appendices to the more important theories involved. Much space is also given to detailed instructions as to how each piece of work, in the construction of different kinds of wells in the alluvial tracts of Northern India, is to be carried out: it is probable that the ordinary reader, unaided by ocular demonstration, will find this part of the book somewhat difficult to follow.

The substance and material contained and discussed in the book are all that could be desired, but Mr. Molony and his publishers can scarcely be congratulated upon the way in which the book has been produced: while reading through the text one cannot but be struck by the want of differentiation between that which is important and that which is comparatively not so. In other words, there is nothing to catch the eye of the reader, and hence he has to give the greatest attention in order to follow the explanations and arguments which are laid down. If only a few of the more salient points, such as the definition of spring and percolation wells, had been given in bold type, the value of the book would have been much enhanced.

There is, in fact, a want of crispness about the whole get up of the book which has the effect of minimising to a very great degree the impression left on the reader's mind, which is fully merited by the matter discussed in the text.—(T. F. MAIN.)

THEOBROMA CACAO OR COCOA. ITS BOTANY, CULTIVATION, CHEMISTRY AND DISEASES. BY HERBERT WRIGHT.

MESSRS. A. M. and J. Ferguson have recently brought out this work and through it Mr. Wright has given us a useful contribution on this important industry. The author has endeavoured throughout to collect all useful information upon the subject and to present to the reader in a concise and systematic manner a full account of the Cacao industry as at present carried on, not only in his own country of Ceylon but also in all the Cacao producing countries of the world. The publication covers the whole field of this industry. The author commences with a careful summary of the world's Cacao producing countries together with the climatic and other conditions prevailing therein and then proceeds to describe the varieties of this crop which are grown in each. Mr. Wright then goes on to treat his subject from all its different aspects, first, as regards methods of cultivation, with reference to which he discusses at considerable length such important points as soils, shade, pruning, grafting, harvesting, curing and the like. This portion of the book is eminently suited for purposes of reference, the various practices being briefly but sufficiently discussed under the headings of each particular country concerned. The writer next devotes a chapter to the Chemistry of the Cocoa tree, in which he gives numerous analyses showing the relative amounts of plant foods removed by each portion of the plant, whether stem, leaves or fruit.

This serves as a useful introduction to a careful essay on the important subject of manuring. Probably the planter will find these chapters, *viz.*, Nos. XII and XIII, the most interesting as the author fully illustrates his views and contentions with the aid of experimental results obtained in countries distributed all over

the world. A chapter on insects and fungoid diseases follows with useful suggestions and instructions as to how these enemies are to be resisted and combated.

Mr. Wright appropriately concludes his book with a summary of the trade and present position of the Cocoa Industry in which he amply demonstrates by means of figures how rapidly this industry is increasing and developing not only in old Cocoa-producing countries but also in new regions hitherto unknown to Cocoa cultivation. The text is suitably illustrated with 18 plates showing typical scenes in Cocoa cultivation.—(T. F. MAIN.)

REPORT OF THE AGRICULTURAL STATION, PALUR, MADRAS, FOR 1905-06. BY C. A. BARBER.

THE First Scientific Report of the Palur Agricultural Station, Madras, has been received at the office of the Inspector-General of Agriculture in India. Mr. C. A. Barber, Economic Botanist to the Government of Madras, has prepared this Report and has devoted himself mainly to giving a justification for the establishment of an Experimental Farm in the South Arcot District. Mr. Barber explains that the object of starting this Station was chiefly to study the groundnut and sugarcane crops. The former ranks second only to paddy in South Arcot and the latter provides an industry which has greatly declined in recent years. Mr. Barber makes out a strong case for the urgent need of scientific assistance in which these crops stand. During the last 50 or 60 years, the groundnut industry has been subject to great fluctuations in point of area which steadily increased until 1892 when it rapidly declined only to rise again in 1899, and to continue increasing till the average acreage under this crop during the period 1901—1906 was no less than 300,000 acres. An investigation into the cause of these fluctuations together with a careful study of the more serious diseases and insect enemies of this crop is now being systematically carried out.

Sugarcane, while never occupying very large acreage, has always been grown in all parts of the district, but the area under

this crop has greatly fallen off within recent years. The fate of the industry has always been closely bound up in that of the European Crushing Mills, and the low prices ruling for sugar during the last few years has compelled the owners either to stop working these mills or offer lower prices for the canes and hence cultivation has decreased. The only remedy for such a state of affairs is to produce a better quality of cane and now there is a great demand for good seed. It is hoped, therefore, that the farm may prove a useful medium for the supply of the best seed cane. —(T. F. MAIN.)

ALCOHOL AS FUEL. BULLETIN NO. 277 OF THE UNITED STATES DEPARTMENT OF AGRICULTURE. BY LUCKE AND WOODWARD.

THOSE interested in oil or gas engines will find much interesting information in Bulletin No. 277 of the U. S. Department of Agriculture, recently compiled by Messrs. Lucke and Woodward. Though the Bulletin is written with the primary object of discussing the prospects of alcohol as a motive power, yet there is a great deal of detail treating of the construction and mechanism of all the more important types of engines now upon the American market. The Bulletin is written with the object of giving assistance to the American farmer who is presumed to have little or no technical training in engineering. The choice of language and use of terms is, therefore, of a simple, easily understood nature. The text is illustrated throughout by diagrams and should be carefully read by those who intend to purchase such an engine. The use of alcohol as a fuel has been rendered possible through the abolition of the duty previously levied upon this article. It appears that the immediate prospects of alcohol replacing kerosene, gasoline or the like as a fuel for these engines is somewhat remote, but there seems a distinct future for it in those districts where transport of fuel is expensive. In such out-of-the-way places alcohol possesses a great advantage over these other fuels in that it can be manufactured on the spot from annual crops such as the molasses of sugarcane or from maize. The cost

of manufacturing a gallon of alcohol from these products is estimated at 6 annas or less. The erection of a small still does not seem out of the way, especially in parts where the co-operative system has come into vogue.

Recent trials with motor cars show that alcohol cannot hope to compete with gasoline or kerosene at present prices, but the chief advantages claimed for it over these fuels is the absence of smell and the higher temperature at which ignition takes place, thus rendering great security from fire. The latter character eminently stamps alcohol as a most desirable fuel to use in ships. It appears that engines constructed for gasoline or kerosene can be run on alcohol quite well without any material alteration in their construction, but greater efficiency is secured if a few minor adjustments are made.—(T. F. MAIN.)